THE EFFECTS OF BACKGROUND MUSIC ON VIDEO GAME PLAY
PERFORMANCE, BEHAVIOR AND EXPERIENCE IN EXTRAVERTS AND
INTROVERTS

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THE EFFECTS OF BACKGROUND MUSIC ON VIDEO GAME PLAY
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SUMMARY

For many, listening to music is an enjoyable experience pursued throughout one's lifetime. Nearly 200 years of music psychology research has revealed the various ways music listening can impact human emotional states, as well as cognitive and motor performance. Music in video games has come a long way from the first chiptunes of 1978 to the full scores written specifically for games today. However, very little is understood of how background game music impacts game performance, behavior and experience. Even less is known for how music variables might affect performance, behavior and experience by individual differences, such as personality type. In this study, 78 participants scoring in the top 30% for their age range of either extraversion or introversion played a cognitive-training game in four music conditions (silence, low tempo, medium tempo, and high tempo). Performance, game play behavior, and flow experience scores were analyzed for each music condition by level of extraversion. While no statistically significant differences were found in game performance scores by level of extraversion, there were statistically significant differences found for play behavior (physical mouse motions) and flow experience for the music conditions. These results suggest that music can both alter the nature of physical game inputs and also provide a more engaging game experience, while not necessarily impacting one's ability to perform in a game.

Keywords: music psychology, video games, individual differences, personality, performance, behavior

CHAPTER 1

INTRODUCTION

Music is an important thematic element for much of popular and modern interactive media. Cinematic scores, sound effects, and other postproduction sounds can augment the overall experience for the media consumer.

Sounds in media, such as those found in movies and games, can be classified as either diegetic or non-diegetic. Diegetic sounds are those derived from objects in the story. For example the voices of characters, sounds of footsteps, or the clash of swords in a battle are all examples of sounds that exist within and are produced by the story world. Non-diegetic sounds, on the other hand, are ones that originate from outside the story space and include musical scores, ambient music, and post-production abstract sound-effects (Gorbman, 1980). Both diegetic and non-diegetic sounds can increase feelings of presence (feelings of being a part of the world one is interacting with (McMahan, 2003)), engagement (a psychological state of absorption, (Lombard & Ditton, 1997)), and immersion (a sense of being completely surrounded by another reality (Murray, 1997)) in the media consumer – particularly in video games (Grimshaw, Lindley, & Nacke, 2008; Nacke, Grimshaw, & Lindley, 2010; Zehnder & Lipscomb, 2006).

While full original orchestral scores have been employed for decades in feature films and television, their use in video games is a recent and expanding phenomenon. The first video games featured 8-bit sounds, known as "chiptunes" because of the computer sound chips that made them possible. The first video game employing a continuous background soundtrack was the 1978 *Space Invaders* (Collins, 2013). Though very basic, these kinds of game sounds can present important feedback to the player and impact

overall performance (Cassidy & Macdonald, 2009; Tafalla, 2007; Tan, Baxa, & Spackman, 2010; Yamada, Fujisawa, & Komori, 2001).

As video games evolved, so did the music that accompanied them. In the 1980s, blockbuster movies were translated into video games, complete with digital versions of the movie score music. By the 2000s, original scores written specifically for video games were featured. Additionally, the advent of higher memory gaming systems, like the Xbox, allowed users to store and listen to their own music while they played their favorite games. In 2012, the Recording Academy made it possible for video game music to be nominated for a Grammy Award. The same year, *Journey* became the first video game to win a Grammy in the category of "best score soundtrack for visual media" (Pinchefsky, 2012).

Research into the domain of music and media has focused primarily on the types of experiences sound might confer. The fields of digital media and human computer interactions (HCI) have both investigated how music affects emotional and experiential variables in media consumption by delving into feelings of presence, engagement, flow, and immersion. Separately, psychologists have researched how music can impact one's cognitive, mental, and emotional state in regards to performing a task. At this present time, there is very little overlap in the application of rigorous psychology methods to HCI and digital media questions.

This research suggests a marrying of a more than a century's worth of music psychology expertise with modern entertainment media research questions. Chiefly, this research asks: how does game music affect game play performance, behavior, and experience and what mediating effects do individual differences play in this domain?

1.1   The effect of music on human performance

While non-diegetic music can contribute to more immersive and positive media experiences, it also can impact performance on a variety of physical and cognitive tasks.

Studies have found that music can exert a positive and significant effect on human performance and exercise efficiency. The power output of muscles (as measured by a friction-loaded cycle ergometer) was found to be higher by participants who had warmed up listening to music as compared to those participants that warmed up without listening to music (Jarraya et al., 2012). Synchronizing athletic movements to music, as in cycling, can improve endurance and efficiency of the exercise (Anshel & Marisi, 1978; Bacon, Myers, & Karageorghis, 2012). Participants who listened to music before exercising on a stationary bicycle traveled more miles than participants who listened to white noise prior to exercise (Becker et al., 1994). Similarly, volleyball players who listened to arousing music while warming up exhibited higher heart rates and peak anaerobic power as compared to those who did not listen to music (Eliakim, Meckel, Nemet, & Eliakim, 2007).

The presence of music can exert significant positive effects on cognitive task performance, as well. "The Mozart Effect" is a controversial phenomenon first reported by Rauscher, Shaw, and Ky (1993) that describes enhanced spatial performance abilities by participants who had listened to a Mozart sonata prior to taking the assessment. Thompson, Schellenberg, and Husain (2001) replicated this study, but also measured levels of arousal and mood. Though participants who listened to the Mozart sonata performed better on spatial ability assessments, they also scored much higher on levels of arousal and mood than those who listened to a slower Albinoni piece, as well as those

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who listened to no music at all. The authors suggest that this result directly supports evidence that the Mozart Effect is an artifact of arousal and mood.

The elements of music that have been attributed to increasing arousal and mood are tempo (fast or slow) and mode (major or minor key) (Husain, Thompson, & Schellenberg, 2002). Fast paced music has been demonstrated to positively affect spatial reasoning abilities as compared to slower tempos. Likewise, major modes affect spatial reasoning performance positively in comparison to minor modes. Finally, arousal is impacted by manipulations of tempo but is not affected by mode. However, mode has a significant impact on participant mood.

Conversely, in some cases, music can also exert a detrimental effect on cognitive performance. The cognitive capacity hypothesis (Kahneman, 1973; Van Merrienboer & Sweller, 2005) offers a possible explanation. By this hypothesis, an individual's limited available cognitive resources might be unduly taxed by the presence of music and the accompanying need to process it. In fact, Konecni (1982) theorized that music processing, in general, exhausts cognitive resources and results in performance decrements.

When performance on a task begins to deteriorate, then an individual is presumably reaching her cognitive capacity limit (Armstrong & Greenberg, 1990). When multiple tasks are performed simultaneously, the combined cognitive demands of the tasks can exceed the available cognitive resources resulting in capacity interference (Norman & Bobrow, 1975).

The presence of music can impact cognitive performance in a number of ways and is task dependent. The tempo of background music, for example, has been shown to

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affect reading comprehension. Participants who listened to slow tempo music performed better on mental arithmetic, free recall, and verbal comprehension tests as compared to those participants who listened to fast tempo music (Furnham & Stephenson, 2007). This result suggests that music containing more beats per minute might create extraneous cognitive load and interfere with a person's performance in certain cognitive tasks.

Relatedly, cognitive task performance can be impacted by the type of music; participants who listened to calm music demonstrated higher recall and comprehension scores than those who listened to upbeat music (Furnham & Strbac, 2002). Kiger (1989) found that low volume, slow tempo, and repetitive music containing low information (based on tonal range, complexity, variety, and loudness) creates a beneficial level of arousal and provides an optimal condition for reading comprehension as compared to high information music or silence.

Additionally, listening to music can impact performance on concurrent cognitive motor tasks. The presence of music can interfere with an individual's performance on typing, for example (Jensen, 1931). Individuals listening to fast music while drinking water will drink faster than if they listened to slower music or no music at all (McElrea & Standing, 1992). Participants in a driving simulator were found to drive faster and use more steering wheel movements as compared to those who listened to slow music or silence (Konz & Mcdougal, 1968). Listening to music while carrying out repetitive tasks can also raise levels of alertness on industrial working tasks (Fox, 1971). It is possible that listening to music reduces the boredom and tedium that often accompanies routine work, as suggested by Smith (1961). As described by the ergogenic sports literature (concerned with the study of external influences that positively impact physical

performance), people will often synchronize their physical motions with music tempo, if music is present (Karageorghis et al., 2010).

In summary, the presence and different qualities of music can exert varied effects on human performance that are task dependent. Cognitive task performance, as in reading comprehension and mental arithmetic, while listening to slow paced, calm, and information-poor (e.g., without vocals) music can be enhanced as compared to listening to fast music or nothing at all. However, by the cognitive capacity hypothesis, music also has the potential to reduce available cognitive resources and result in a performance deficit for some tasks. Physical task performance can benefit when a person listens to fast paced and exciting music because levels arousal and mood are augmented.

There exists a balance between the arousal-mood and cognitive capacity hypotheses that is not well understood. Should the cognitive costs of background music be greater than the benefits of increased arousal and mood, then an individual might experience decreased task performance. On the other hand, if arousal and mood increases are such that they outweigh detriments due to reduced cognitive capacity, then an individual might excel because of the presence of music. The precariousness of this relationship is reflected in a meta-analysis on the effect of background music on task performance. Overall, a null effect was found on the benefits and costs of background music on cognitive task performance (Kämpfe, Sedlmeier, & Renkewitz, 2011).

1.2   *Personality, music, and cognitive performance*
Another variable affecting music's effects on cognitive task performance is personality. The optimum threshold of arousal differs for extraverts and introverts (Eysenck, 1967). Extraverts tend to seek stimulating environments to match their higher

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optimum arousal thresholds, whereas introverts do not need as much stimulation to reach their optimum arousal threshold. In the context of work, a study by Campbell and Hawley (1982) found that extraverts working in a library chose busier areas than introverts, who shied away from such activity. In distracting work environments, task performance of introverts decreases whereas the performance of extraverts is improved (Morgenstern, Hodgson, & Law, 1974).

Another study electro-dermally measured the basal arousal levels of extraverts and introverts as they listened to simple auditory tones (Smith, Wilson, & Davidson, 1984). Participant arousal levels were also artificially manipulated by the administration of caffeine. Performance on a cognitive task was affected in both personality types by the presence of a tone, with introverts exhibiting larger response magnitudes in physiological arousal as compared to extraverts.

In the context of music, extraverts reported listening to music while working twice as often as compared to introverts (Daoussis & McKelvie, 1986). The authors of this study hypothesize that extraverts use music to raise their arousal levels to an optimum threshold, while introverts do this less often because of their naturally lower levels of optimum arousal. Both personality types reported to listening to low volumes of background music while working. This same study also investigated the performance scores of extraverts and introverts on a reading recall test in the presence of music. As expected, the performance of introverts was significantly and negatively affected by the presence of music whereas extraverts showed no performance decrement.

A study by Furnham & Allass (1989) further investigated how introverts are negatively impacted by music as a distraction in a variety of cognitive tasks. For a task

that involved memorizing a set of pictures, the presence of music significantly and negatively lowered the recall of images after six minutes for introverts. Immediate recall was only marginally worse for introverts compared to extraverts. The authors suggest that introverts might incur more negative effects for some mental processes, such as attention and recall, in the presence of music than extraverts do. Similarly, Furnham, Gunter and Peterson (1994) found a significant interaction between condition type (TV playing sound vs. TV not playing sound) and personality type for participants being tested on reading comprehension. Extraverts exhibited higher performance as compared to introverts in the distracting environment, though both personality types performed best in silence.

In summary, the presence of music and sound has been shown to affect personality types differently. Generally, extraverts perform better than introverts in distracting environments and this is attributed to the ability, and often desire, of extraverts to process and seek out stimulating environments. Both personality types usually experience some performance decline in the presence of music as compared to silence, however, and this is likely due to an exhaustion of cognitive resources necessary to process the distraction.

1.3   The use of music in video games

Games are becoming an increasingly pervasive and accepted form of entertainment. In 2013, the US games industry revenue at $22.8 billion (McDonald, 2013) far surpassed both the US music (at $16.5 billion (Pfanner, 2013)) and movie (at $10.9 billion (MPAA, 2013)) industry's revenues. Increasingly, complex music is being written for and featured in video games yet very little is understood on how this music affects the performance,

behavior, and experience of the person playing them.

A common convention in game music is to employ fast-paced and exciting songs for difficult levels containing hard-to-beat characters. An interesting question is whether this rapidly accelerating music helps or hinders a player's performance. Perhaps more exciting music aids a player by increasing their arousal to a point where it beneficially impacts performance. The alternative could be that exciting music burdens them with extraneous cognitive load and hinders their overall play performance. One of the questions this research asks is how music tempo (measured in beats per minute) might affect a player's performance in a video game.

Even the most basic games present cognitive and physical challenges to the player. In order to play a game one must understand and remember the rules, play within the constraints of the game world, and perform the appropriate physical actions in order to interact with the system supporting the game. For game tasks that are cognitive in nature (e.g., multitasking, sorting, memorizing, timing), music might impact performance in a manner similar to what has been previously described in the cognitive music psychology literature. Music might also exert an effect on the physical aspects of playing, such as keeping pace or timing moves, in certain kinds of games.

To date, very few studies have examined the effect music tempo has on game play performance, behavior, or experience. One study, a Master's thesis by Lawrence (2012), explored the effect of background music tempo on performance in *Tetris* but yielded no statistically significant results. The author attributes the lack of findings to the small sample size and pre-existing familiarity of the game by participants.

Understanding how background music can affect a player's performance could be

very useful for both commercial and therapeutic (also known as "serious") games. For example, many commercial games allow a user to play at a desired level of difficulty. Players can choose if they will play at a sustained "insanity" level of difficulty or at a much more casual pace. Many games also employ dynamic difficulty adjustment (DDA) whereby algorithms analyze player behavior and tailor the game play to suit their level of ability. The goal of DDA is to keep a player at an optimum threshold of arousal where the player will not become too bored or too frustrated, as according to the theory of flow (Csikszentmihalyi & Csikszentmihalyi, 1992). Flow represents an optimal state of engagement where a person's ability perfectly meets the challenge of the activity. Altering a music element, such as tempo, could potentially create an optimum state of arousal that could lead to an optimal playing experience - both in terms of how the game feels and how well the player performs. For a commercial game, this could lead to a more overall fun playing experience. For a serious game seeking to confer therapeutic benefit, appropriately controlled music could significantly impact therapeutic gain.

Though some researchers have looked into the different video game genres certain personality types prefer (Peever, Johnson, & Gardner, 2012), no study has yet examined the interaction of extraversion level and music on video game play performance. As with the effect of music tempo, understanding how game music can impact extraverts and introverts differently could have implications for game design.

A primary current limitation of games research is the inability to use custom made games. Currently, most games-based research uses commercially available games, such as *World of Warcraft* (Whitlock & McLaughlin, 2010) and *Boom Blox* (Levy et al., 2012). Using these games in studies requires extensive manual coding of end-game

performance scores, and much of the data regarding player behavior is lost. This study examines a solution that enables for a more in-depth analysis of game play performance.

As described fully in the Methods below, *Food for Thought* is a custom game built by a team of Georgia Tech researchers; it was initially designed as a cognitive training game for older adults (Gandy, McLaughlin, Levy, Solomon, & Allaire, 2013). *Food for Thought* automatically logs detailed game play behavior in a saved XML file, along with many other time-stamped variables described later. This game is also easily customizable in terms of data collected, amount of difficulty, and types of levels played. *Food for Thought* presents researchers with a rare opportunity to finely examine how a player engages with a game.

1.4 Hypotheses

The first hypothesis of this study is that the presence of music (over silence) will improve overall game play performance in participants, as compared to silence conditions, by the arousal-mood hypothesis. *Food for Thought* does not require a player to read much text, therefore it is not expected that music will impact performance by detrimentally affecting comprehension of instructions. Instead some tasks, like spatial reasoning, in *Food for Thought* may be benefitted by the presence of music (similar to the Mozart Effect). Additionally, players might find it helpful to synchronize their motor movements playing the game with background music. There also is an expectation that conditions with music will yield more positive experiences of engagement (measured by the flow scale) with the game, as compared to conditions played in silence (see Figure 1).

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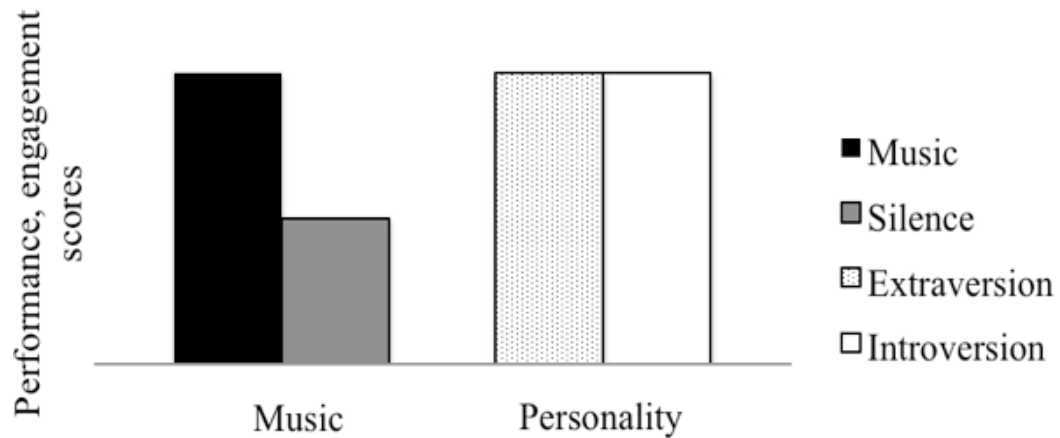
Figure 1. Hypothesized effects of music conditions and personality type on performance and engagement scores.

I hypothesize that game play behavior, particularly mouse movements, will be affected by conditions containing music. As has been shown in the literature with concurrent motor movement timing to music, there is an expectation that participants might similarly time their mouse actions to the music rhythm. This might produce more mouse movements than expected that are not directly tied to playing the game. Players also might play through levels faster, while also spending less time on the planning and reviewing game stage screens if the music tempo encourages them to progress faster than they would otherwise in silence.

There is no expectation that there will be a main effect of extraversion level and game play performance. At its heart, *Food for Thought* is a multitasking game. Currently, findings in the literature are unclear as to whether level of extraversion impacts multitasking performance (Konig, Buhner, & Murling, 2005; Lieberman & Rosenthal, 2001; Szymura & Nęcka, 1998). As of this time, there is no reason to believe that either personality is more capable of performing in the game's multitasking challenges.

Per the previously discussed music psychology literature, I hypothesize an

interaction of music condition and level of extraversion on game play performance and

experience. Four hypotheses are expected in this interaction (see Figure 2).
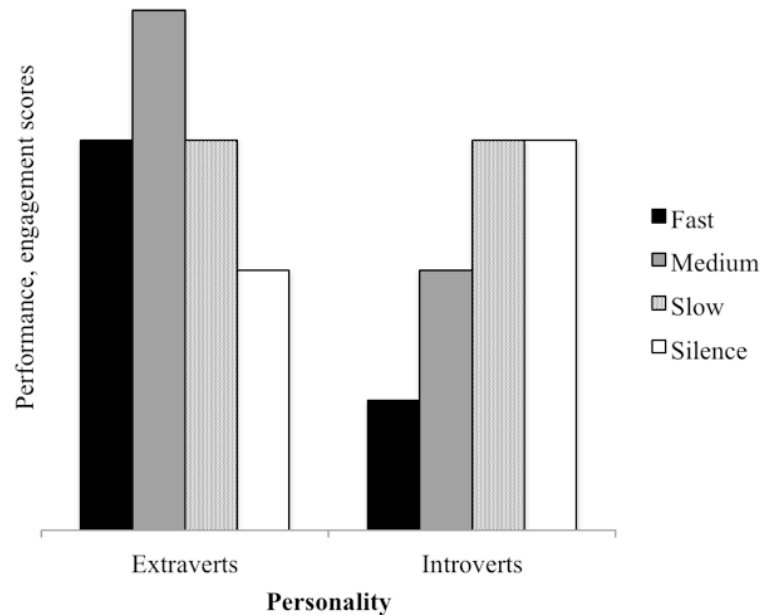
Figure 2. Hypothesized interaction in game performance and engagement scores for music conditions by
level of extraversion.

     The first hypothesis is that fast tempo music will detrimentally affect play

performance in both extraverts and introverts by the cognitive capacity hypothesis, as

compared to slower paced music. Participants exposed to higher beats per minute will

experience higher cognitive load to the detriment of their game play performance. The

second hypothesis is that the magnitude of the game play performance detriment due to

fast tempo music will be greater for introverts because of their lower preferred threshold

for arousal. The third hypothesis is that the highest feelings of flow will be reported by

extraverts playing the game with fast tempo music, as this condition will better meet their

optimum arousal threshold. Finally, I hypothesize the lowest feelings of flow and

engagement will be reported by introverts playing the game with fast tempo music, as this condition will far exceed their optimum arousal threshold.

CHAPTER 2

METHOD

This study occurred in two stages. The first stage determined eligibility for the second stage of the study via a pre-screening questionnaire. This pre-screen contained a demographics questionnaire coupled with the Big Five Inventory – 44 item, scores from the latter determined placement in the full study.

The second stage of the study occurred in two sessions over two days. The second session was scheduled to take place within six days of the first. On the first day, participants completed an informed consent packet, took the SynWin multi-tasking battery, played *Food for Thought* in two randomly assigned music conditions, and completed a flow questionnaire at the end of each music condition. On the second day, participants played in their remaining two randomly assigned music conditions completing the flow questionnaire at the end of each condition. At the end of the final condition, participants completed an exit questionnaire.

2.1 Participants

Participants were 78 students (25 female, 53 male) recruited from the Georgia Institute of Technology (54 participants), Kennesaw State University (KSU) Marietta Campus (9 participants), and the general population (15 participants). Georgia Tech and KSU students received course credit for participating in this study, while those from the general population received $20 in compensation for study completion. Participants were between the ages of 18 and 39 (see Table 1).

Table 1. Participant demographics.

Demographic information of N=78 participants	
	M (SD)
Age	22.03 (4.28)
	Percent
Gender	
Female	32.1%
Male	67.9%
Level of Education	
High school graduate / GED	77.1%
Bachelor's degree	14.0%
Some graduate work	4.0%
Master's degree	2.9%
MD, JD, PhD, or other advanced degree	1.0%
Student type	
Undergraduate	75.0%
Not currently a student	17.6%
Graduate	7.4%
Recruited from	
Georgia Tech	69.2%
General population	19.2%
KSU Marietta Campus	11.5%

2.2 Design

This study utilized a 4x2 within-subjects, repeated measures, counterbalanced design with two independent variables of music condition (silence, low tempo, medium tempo, high tempo) and level of extraversion (either introverted or extraverted). Dependent variables included game play performance, game play behavior, and flow scores.

2.3 Materials

Pre-questionnaire

All participants were pre-screened for eligibility via an online Qualtrics survey (Appendix B). This survey contained an online consent form (Appendix A) for the pre-screening portion of the study followed by a demographics questionnaire collecting information on age, gender, education level, and major area of study. The Attitudes Towards Computers questionnaire (Jay & Willis, 1992), changed so every reference to "computer" was replaced with "video game", was given to assess attitudes and

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experience with video games. Following this was the Computer Usage Questionnaire assessing a participant's use of various computer software (Schroeders & Wilhelm, 2011). The Positive and Negative Affect Schedule (PANAS) assessed levels of positive and negative affect over the participant's previous 24 hours (Watson, Clark, & Tellegen, 1988). This pre-questionnaire packet is useful in identifying, if any, aberrant or outlier player behavior scores that might be a product of quality of life issues, attitudes towards technology, or experience with technology.

Finally, participants completed the 44-Item Big Five Inventory (BFI-44; Appendix C) (Rammstedt & John, 2007). For qualification into the full study, participants needed to score in the top 30% of their age range for extraversion or introversion as based on a sample of 132,515 participant BFI scores collected by Srivastava, John, Gosling, and Potter (2003). This pre-questionnaire took participants an average of 15 minutes to complete.

SynWin

On the first in-person session day, eligible participants completed SynWin (see Figure 3), which is a digitally administered multitasking environment that presents two cognitive (memory and arithmetic) and two perceptual tasks (perceptual and auditory monitoring) to the user (Elsmore, 1994; Proctor, Wang, & Pick, 1998; Wong, 2005).
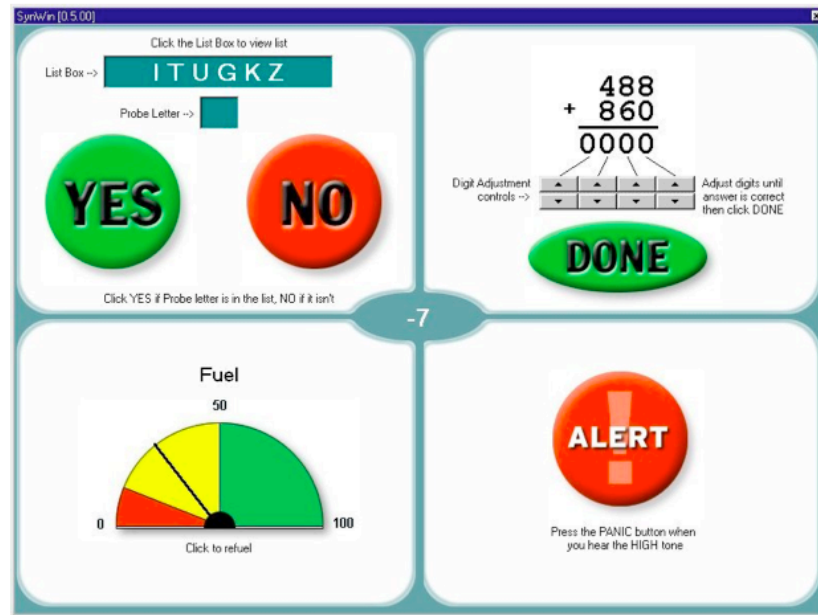
Figure 3. SynWin screenshot with the memory, arithmetic, auditory monitoring, and visual monitoring tasks (clockwise).

Individual task and global scores generated by the tool provide information on a person's ability to parallelize multiple tasks. SynWin is customizable in terms of difficulty and length of task presentation, though the program's default settings were used in this study. Proctor et al. (1998) evaluated SynWin (then known as SYNWORK1) as a valuable tool in measuring arousal-related variables and complex task performance. SynWin has been evaluated in studies investigating sleep deprivation (Elsmore, 1994), cognitive computer games (Kearney, 2005), and concurrent complex task performance (Salthouse, Hambrick, Lukas, & Dell, 1996).

Food for Thought

Participants in the full study played *Food for Thought* in two 30-minute play rounds per session day.

Food for Thought is a one-player multitasking computer game, similar to a real time

strategy (RTS) or time management game that challenges players to complete a meal

recipe by sending ingredients through different stations (see Figure 4).
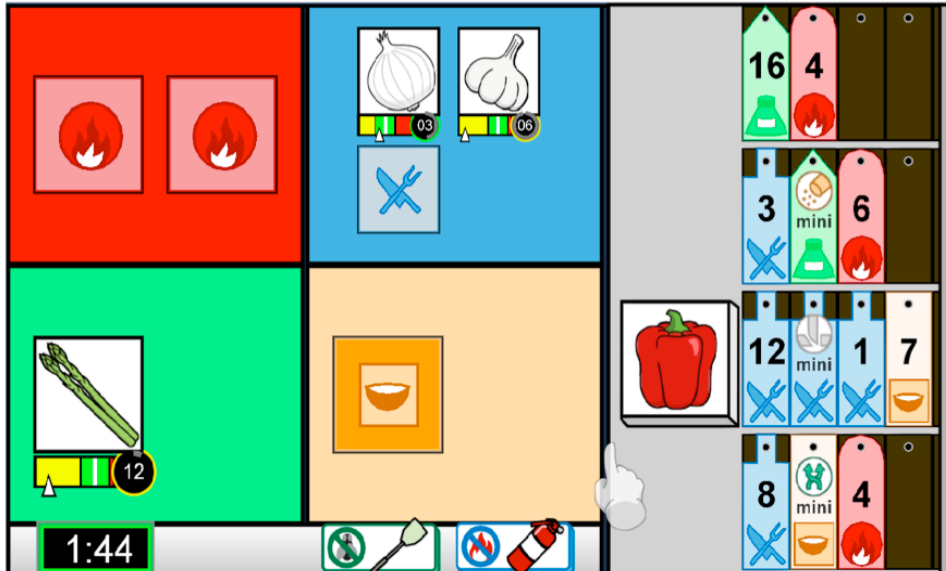
Figure 4. Screenshot of the *Food for Thought* kitchen with the four game stations (clockwise): cooking, chopping, prepping, and spicing. Ingredients waiting to be sent to these four stations are located on the countertop on the right of the screen.

The design of *Food for Thought* encourages planning ahead, multi-tasking, and

reviewing feedback for an optimal score. Additionally, mini-games that occur in parallel

to the rest of the game play add extra complexity (see Figure 5). Players variably

prioritize mini-games and the kitchen game play by swapping between the screens to

attend to various tasks.
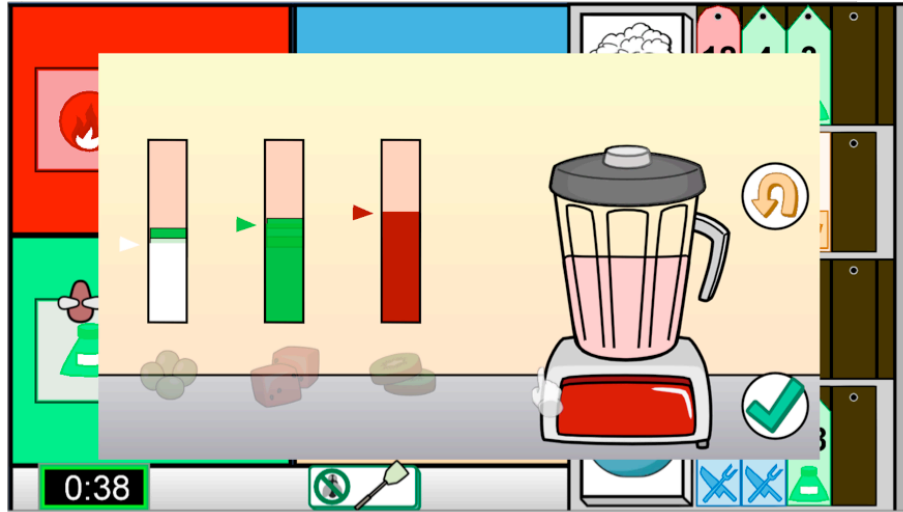
Figure 5. The blending mini-game is a spatial estimation task challenging players to blend ingredients evenly.

Numbers on each ingredient tab tell the player how long each ingredient needs to spend at each station. Players can use these numbers to plan their moves so that they play as efficiently as possible. Successful and efficient players of *Food for Thought* are those that can handle many ingredients at once, keep track of different ingredient finishing times, and attend to mini-games that take their attention away from the game kitchen. The game level timer challenges players to finish their recipe in the time allotted. If a player runs out of time, the level continues but players will lose points. Feedback screens at the end of each level describe the score in detail so that the player might understand why they received the score that they did (see Figure 6).

Figure 6. Scoring screen seen at the end of a level. This player scored four stars out of five. The remaining outlined, but not filled, star indicates the player lost points on Freshness for leaving an ingredient out on the countertop for too long.

The game assigns players a star rating score at the end of each level that reflects their performance on the dish they cooked, with five stars being the highest possible score. The overall score is impacted by a player improperly cooking, mixing, chopping, and stirring ingredients, as well as poor performance in the mini-games (e.g., incorrectly sorting red and green bell peppers, incorrectly estimating ratios of smoothie ingredients) and leaving ingredients on the countertop for too long (decreases Freshness rating). Mini-game scores, also out of five stars, reflect a player's performance in managing the mini-game while kitchen events are occurring.

Five kinds of mini-games are played concurrently in the game: 1) the stirring mini-game requires a player to keep vegetables moving in a pan so that they do not burn (challenges mental time simulation and estimation), 2) the chopping mini-game has players make even and correct numbers of slices across a potato (challenges spatial

reasoning), 3) the spicing mini-game has players identifying and choosing a spice bottle with the correct color and shape for a cake (challenges visual search), 4) the blending mini-game has players correctly blending ingredients with different time requirements (challenges spatial reasoning), and 5) the sorting mini-game requires players to correctly sort bell peppers of different colors without knocking them off a table (challenges visual search, see Figure 7 continued on next page).

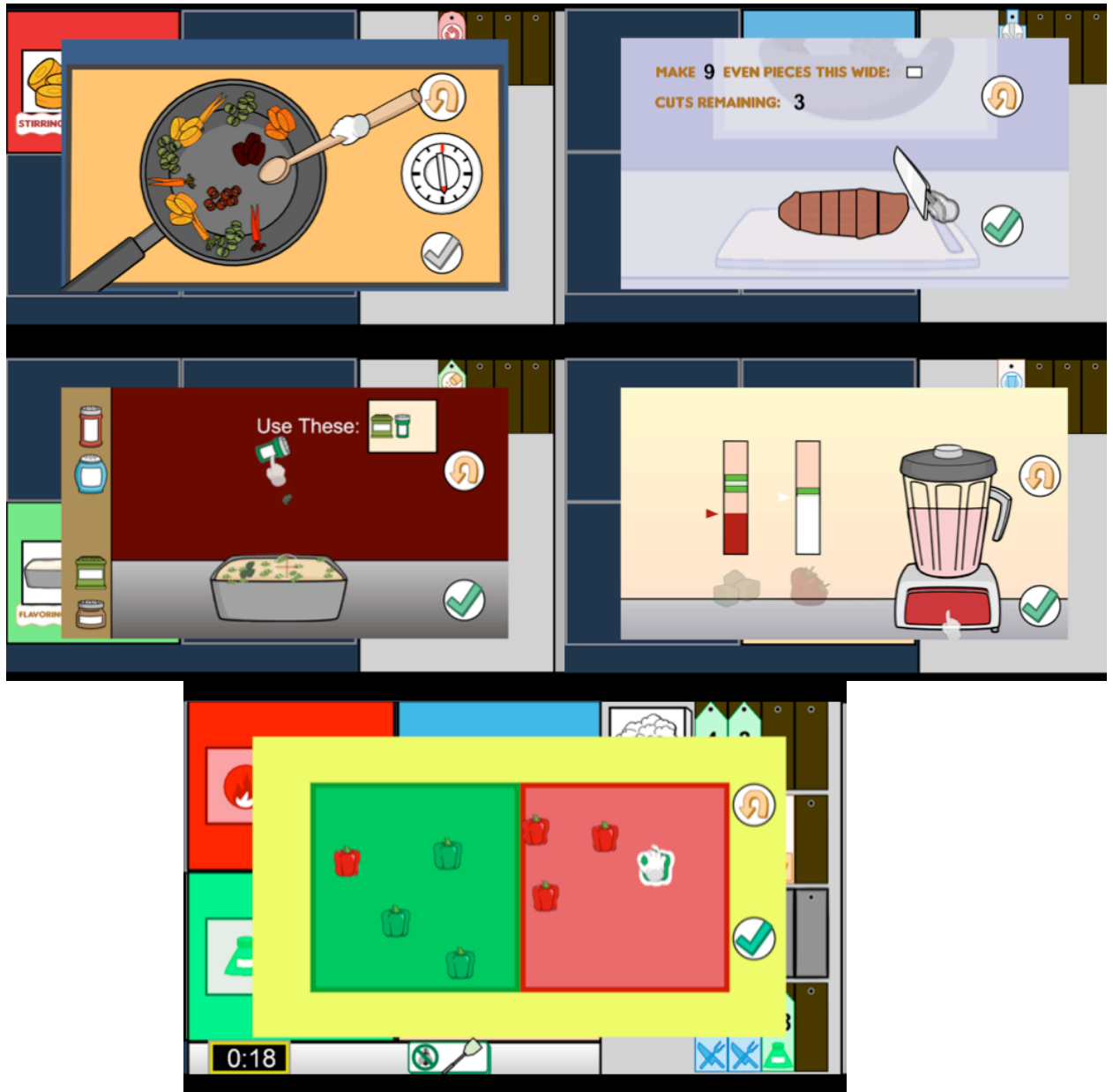*Figure 7*. Mini-games in *Food for Thought*: stirring, chopping, spicing, blending, and sorting.

Food for Thought was initially designed as a cognitive training game by researchers at the Interactive Media Technology Center (IMTC) at Georgia Tech and at North Carolina State University as part of a four year National Science Foundation funded cognitive gaming study. This game was chosen for this study because of the

cognitive task challenges it presents to a player. Though many other game genres could have been considered for this study, it is the cognitive nature of *Food for Thought* that makes it particularly appropriate for this research. The game contains many similar types of cognitive tasks that have been traditionally studied in the music study literature body, such as spatial reasoning and exercising the executive control function.

Another advantage to using this game is in its customizability and data logging capabilities. *Food for Thought* is a highly customizable game that allows non-programmers the ability to design their own levels based on difficulty (how many steps necessary to complete a level within a certain time), complexity (how many steps possible to complete at once, including mini-games), level length, recipe type, and more. The game is also designed to log all game actions and play behaviors on the backend and save these data to an XML file. The ability to have extensive logs of player action behavior makes *Food for Thought* a powerful tool in understanding how players are engaging in the game, at both high and low level details.

Some examples of logged *Food for Thought* variables are overall game performance, specific station game performance, mini-game performance, time to complete a level, location of mouse, mouse movements, number of retried levels, time spent planning before a level, and time spent reviewing end of level score. The data are time stamped and easily imported to statistical software, like SPSS, via a parsing code. This parser code is also highly customizable for extraction of other variables of interest.

Music

Approximately 250 hours worth of music were chosen from a digital song library for participants to listen to while playing *Food for Thought*.

Tempo was chosen as the manipulated music variable because it describes a level of information load. Tempo is typically measured in beats per minute (BPM) and describes the speed at which a musical piece progresses at (Oakes, 2000). Higher BPMs indicate more information per unit time presented to the listener.

Original song tempos were altered and pitch controlled to 70, 90, and 120 beats per minute. The upper and lower tempos were chosen to be outside of the ranges found by Milliman (1982), where 95% of participants rated "slow music" as being 72BPM and below and "fast music" as 94BPM and above. Milliman's survey results would likely be different today, as most of popular music has been heavily influenced by the mid-1980's introduction of house and electronic music that frequently exceeds 120BPM.

Selected music was chosen specifically to satisfy a number of requirements.

First, all songs were instrumental only and contained no vocals. Using instrumental music should have removed extraneous cognitive load of processing words, though a paper by Furnham, Trew, and Sneade (1999) found no significant impairment of task performance by extraverts and introverts listening to music with vocals. The original tempo of the song was identified using the software program, VirtualDJ, and had to have been between 85 and 95 beats per minute (mid-tempo) for inclusion. This would mean fewer noise artifacts would be generated when the song's tempo was later changed to the high and low extremes of 70 and 120 beats per minute.

All music came from similar genres, most often tagged by the song library as "rock" and "electronic pop". Common to both rock and electronic music is a song structure of verse, pre-chorus, chorus, verse, pre-chorus, chorus, bridge, verse, and chorus (Campbell

& Brody, 2007) . The similarity in genres chosen for this study meant that nearly all songs followed the above progression. Music was also chosen for possessing similar types and numbers of instruments throughout the song (typically one or two guitars, bass guitar, snare, bass drum, and keyboard or synthesizer).

In terms of rhythm, all songs had a strong quarter note presence ("four on the floor") meaning the bass drum hit on every beat. Songs also did not contain any sixteenth or triplet notes, as these could change the perception of a song to be artificially fast. Finally, all included songs were in a major key to remove confounding effects of mode on emotion. Two key detection software programs (VirtualDJ and KeyFinder) were used based on their relatively high accuracy in correctly identifying song keys, according to a report testing accuracy for 12 of the best commercial programs (White, 2014). In this report, VirtualDJ was found to be 65% accurate while KeyFinder was found to be 77% accurate. In order for a song to be included in the study, both key detector programs must have agreed on it being a major key.

Twenty-five songs satisfying the aforementioned requirements were assigned to a fixed playlist order and their tempo modified using Pro Tools 8. Four playlist batches were generated for the four counterbalanced conditions, such that every participant listened to the same song in the same order but at different tempos based on the counterbalancing.

Technology
Participants used noise-reducing Sony MDRV6 headphones, widely regarded as quality mid-range headphones, throughout the study to listen to the music playlists. These headphones were chosen not only for the reputation, but also for their high ratings on ear-

cup comfort. Playlists were loaded into separate VLC player windows and played in the background while the game ran in the foreground.

Computers running *Food for Thought* were Dell Inspiron 750 computers with 17" LCD screens with a resolution of 1280x1024. *Food for Thought* is not a graphics intensive program, and these machines were more than capable of running the game.

Flow questionnaire

At the end of each 30-minute play window, participants immediately completed the Flow Scale (Appendix D) online hosted by Qualtrics. This questionnaire is used to assess flow, an optimal psychological state of immersion, engagement, and enjoyment. Thirty-six items are scored across nine subscales of Challenge-Skill Balance, Action-Awareness Merging, Clear Goals, Unambiguous Feedback, Concentration on Task at Hand, Sense of Control, Loss of Self-Consciousness, Transformation of Time, and Autotelic Experience (Jackson & Marsh, 1996).

Exit questionnaire

After the final 30-minute play condition on the last session day, participants completed an exit questionnaire (Appendix E) that included questions on their experience of playing the game with and without music, the Short Test of Music Preferences (STOMP) (Rentfrow & Gosling, 2003), and questions on frequency and duration of weekly game play.

2.4 Procedure

Interested participants who scored in the top 30% for either extraversion or introversion for their age on the pre-screen were contacted and scheduled for two in-person study sessions, each session occurring within six days of each other. Sessions

were conducted in private laboratories either at either Georgia Tech or the KSU Marietta

Campus (formerly known as Southern Polytechnic University). Participants were

randomly assigned to one of four batch conditions (see Table 2) that determined the order

of the music conditions they would encounter.

Table 2. Counterbalanced study design has participants playing Food for Thought in each of the four
condition types over two session days, by level of extraversion.

	Session 1	Session 2
9 participants	Silence, medium BPM	Low BPM, high BPM
10 participants	Low BPM, silence BPM	High BPM, Medium BPM
9 participants	Medium BPM, high BPM	Silence, low BPM
10 participants	High BPM, low BPM	Medium BPM, silence

39 extraverts, 39 introverts = 78 total participants

While a true counterbalancing schedule would make this study infeasible in

resources and timeline, this above plan distributes a similar pattern of order presentations

across the design. For example, in the third batch participants experience one step "up" in

tempo (e.g., medium to high BPM) while participants in the second batch experience one

step "down (e.g., high to medium BPM). The first and fourth batches have two steps "up"

and "down", respectively.

On the first day, participants completed an informed consent for participation in the

full study. The researcher then explained how to complete SynWin in a five-minute

tutorial and loaded a practice version of SynWin so that participants could practice each

task on its own for one minute each, then all tasks at once for one minute. After

completion of the practice session, participants were allowed to ask questions. Then the full SynWin version was loaded for participants to complete requiring them to manage all tasks at once for five minutes to achieve their best score.

The researcher conducted a 15-minute step-by-step oral tutorial where participants learned how to pay all stages of the game. At the end of the tutorial, the researcher answered any questions participants might have had.

To ensure a comfortable and appropriate volume for the participant, a volume check was performed before the music and study levels were loaded. Participants self-selected a preferred volume level in the system task bar for the entirety of the session. The appropriate condition playlist ran in the background in VLC Media Player. Headphones were always worn during game play, even in the silent condition.

Participants played *Food for Thought* for 30 minutes, finishing whatever level they were on at the end of minute 29. The experimenter would then close the game and load the Qualtrics link for the flow survey in a web browser. The flow survey was explained each time it was presented and the experimenter stressed that answers should be just for the past 30 minutes of game play (no other play condition). After all participants completed the flow survey, the next condition playlist was initiated and *Food for Thought* re-loaded. On re-start, the game would load the level next in the queue for that particular participant's unique ID number. After another 30 minutes of gameplay, the game was again closed and the flow survey completed. This first day session took approximately two hours.

On the second day, participants were reminded how to play the game with a quick tutorial covering the games rules and strategy. Another volume check was performed, the

appropriate music playlist loaded, and participants played for 30 minutes taking the flow survey immediately following the end of gameplay. Next, participants played another 30 minutes in the final music condition type, completed the flow survey immediately after, and then completed the exit-questionnaire. Participants were finally debriefed and thanked for their time. The second day sessions lasted approximately one and a half hours.

CHAPTER 3

RESULTS

In this study, the primary objectives were to identify the effects, if any, of music tempo on video game performance, game play behavior, and game play experience.

3.1 Pre-questionnaire and assessments

Big Five Inventory

All eligible participants scored in the top 30% of their age range for either introversion or extraversion. The average extraversion level for the 39 introverts was 2.35 (SD = 0.36, max = 2.75, min = 1.38) out five points. The average extraversion level for the 39 extraverts was 4.19 (SD = 0.38, max = 5, min = 3.75).

Wellness

Participants reported low levels of negative affect (mean = 1.65, SD = 0.48) and moderate levels of positive affect (mean = 3.4, SD = 0.67), indicating they were experiencing generally positive feelings the 24 hours prior to their first session.

Technical experience and attitudes

Due to a Qualtrics server issue, some data from the pre-questionnaire was lost regarding technical experience and attitudes. Sample sizes are noted as needed in this text.

Participants had positive attitudes towards video games and computer technologies, as reported on the Attitudes Towards Computers questionnaire. Responses indicated that participants felt neither threatened nor confused by video games or

computers (where 3 is "neither agree nor disagree" and indicates accepting feelings towards technology, mean = 3.12, SD = 0.11, n = 61).

Generally participants were frequent users of technology and reported a high level of technical savvy by the Computer Usage Questionnaire (where 5 is using the questioned programs "Very Often", mean = 3.92, SD = 0.48, n = 61), which is not surprising for this sample source. There were no statistically significant differences found in computer usage between the two levels of extraversion, $F (1, 60) = 2.69$, $p = 0.11$.

SynWin

Due to technical difficulties with administrative installation privileges on KSU computers, not all participant SynWin data was captured. Ultimately, 66 SynWin data logs were captured for use in the following analysis. One participant's SynWin math score was removed from the data as it was a significant outlier.

Participants performed competently on SynWin and no statistically significant differences were found on the global SynWin score due to level of extraversion (see Table 3).

Table 3. SynWin ANOVA results by level of extraversion

	df	*F*	η	*p*
Global Score	65	0.03	724.97	0.87
Memory	64	3.13	5902.97	0.07
Math	65	0.01	227.92	0.92
Visual monitoring	65	0.84	245.75	0.36
Auditoring monitoring	65	1.00	455.30	0.32

*Significant at $p < 0.05$
**Significant at $p < 0.01$

There was no statistically significant correlation found between global SynWin scores and performance in *Food for Thought* in either the silence (r (66) = 0.08, p = 0.52) or music (r (66) = 0.8, p = 0.53) conditions. Additionally, there was no significant correlation between global SynWin scores and level of extraversion (continuous variable), r (66) = 0.01, p = 0.95.

3.2   Exit Questionnaire

Music preferences

The Short Test of Musical Preferences (STOMP) asks participants "which musical styles do you choose to listen to on a regular basis?" and lists 25 genres with room to write-in two more. The most popular genres selected by participants to willingly listen to were Rock (74.7%), Pop (67.1%), Alternative (64.6%), Electronic/Dance (63.3%), and Indie (50.6%).

Game play characteristics

Sixty-seven participants (85.9%) reported that they currently play video games and with more than half (56.7%) playing between 8 and 10 hours a week. The most popular game genres to play by participants included Adventure (70.9%), Action (68.4%), First-person Shooter (64.6%), and Role-playing (60.8%) games. Some of the genres least preferred were Fighting (39.2%), Party (30.4%), Sports (21.5%), and Flight (15.2%).

3.3   Effects of music

Order effects

The counterbalanced design assumed roughly equal distribution of error that might have been introduced by the order presentation of conditions. There were no order

effects found in any of the dependent variables of interest. Most importantly there were no order effects on game play performance, $F(3, 216) = 0.247$, $p = 0.86$.

Music and game performance

Overall participants performed competently playing *Food for Thought*, by scoring an average of 4.28 of 5 stars (approximately 85% of total possible points, see Table 4).

Table 4. Food for Thought overall level performance (highest rating is 5 stars)

	Mean	*SD*	*Max*	*Min*
Silence	4.28	0.33	4.86	3.1
Low tempo	4.24	0.42	4.83	2.17
Medium Tempo	4.27	0.41	4.80	2.84
High tempo	4.26	0.39	4.81	2.60

In a mixed ANOVA between the four conditions, no statistically significant differences were found in overall game performance for the effect of music, $F(3, 231) = 0.197$, $p = 0.90$. In treating the silence condition as a control and taking a game performance average for the other three tempo conditions, no statistically significant differences were found either for game performance between silence and music, $F(1, 77) = 0.039$, $p = 0.85$ or for extraversion level, $F(1, 77) = 0.120$, $p = 0.73$. Additionally, there were no statistically significant differences found for the effect of music on mini-game performance, $F(3, 74) = 1.624$, $p = 0.19$. Again, in treating the silence condition as control and looking at mini-game performance for conditions with music, there also was no statistically significant difference in performance between silence and music, $F = (1, 74) = 1.878$, $p = 0.18$.

This raises the question if the absence of an effect was due to the experimental condition or possibly the level design difficulty progression. A linear regression was conducted to test, on a more detailed level, if binned condition levels were predictors of performance. That is, each condition (including approximately 18 levels each) was split in half. This resulted in eight bins describing level performance over the four condition types. A linear regression was performed to see if these more detailed time windows and level of extraversion predicted game play performance for the four music conditions. Should this model be found to be statistically significant, it would suggest that the level design did not follow an appropriate difficulty projection. For example, if the model predicted that playing in the last condition bins meant a player's performance was high then that would suggest a player's skill was outpacing the demands of the game. The result of this regression was not found to be statistically significant, with the model only explaining 0.8% of the variance ($R^2 = 0.008$, $F(8, 263) = 0.631$, $p = 0.752$, see Table 5).

Table 5. Linear regression results for binned conditions in the game

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	*Std. Error*	*Beta*	*t*	*Sig.*
Constant	4.20	0.05		55.97	0.00
Extraversion level	0.50	0.04	0.05	1.33	0.18
Bin 1, day 1	0.61	0.07	0.45	0.84	0.40
Bin 2, day 1	-0.05	0.07	-0.04	-0.69	0.49
Bin 3, day 2	0.16	0.07	0.01	0.23	0.82
Bin 4, day 2	-0.01	0.07	-0.01	-0.17	0.86
Bin 5, day 3	0.10	0.07	0.01	0.15	0.88
Bin 6, day 3	-0.01	0.07	-0.01	-0.10	0.93
Bin 7, day 4	0.05	0.07	0.04	0.67	0.51

Music and game play behavior

Participants spent an average of 13.93 seconds (SD = 8.25) in the planning screen in the silent condition and 13.01 seconds (SD = 5.16) in conditions with music (see Table 6). No statistically significant differences were found between silent and music conditions for the numbers of seconds spent in the planning screen, $F(1, 76) = 1.55$, $p = 0.22$. The average length of playtime in a level was found to be 88.80 seconds (SD = 9.64) in the silent condition and 88.80 seconds (SD = 9.70) in the music conditions. There were also no statistically significant differences found between length of level playtime in silent and music conditions, $F(1, 76) = 0.001$, $p = 0.97$.

Table 6. Participant times spent in the three game stages of planning, playing, and review

Times spent in game stages (seconds, n = 78)				
	Minimum	Maximum	Mean	Std. Deviation
Planning - silence	4.73	46.14	13.93	8.25
Planning - low tempo	4.03	30.47	12.20	5.73
Planning - medium tempo	4.01	40.84	13.74	7.08
Planning - high tempo	4.07	36.27	13.09	6.15
Playtime - silence	63.71	117.27	88.80	9.64
Playtime - low tempo	16.68	135.50	87.84	13.87
Playtime - medium	66.05	122.53	89.30	9.48
Playtime - high	65.27	122.45	89.14	10.44
Review - silence	1.67	13.86	4.56	2.72
Review - low	1.19	90.55	5.45	10.24
Review - medium	1.40	11.45	4.28	2.56
Review - high	1.33	18.47	4.61	3.06

The average time spent reviewing end level feedback was 4.56 seconds (SD = 2.72) in the silent condition and 4.78 seconds (SD = 3.92) in the music conditions. Here, there also were no statistically significant differences in average time spent reviewing between silent and music conditions, $F(1, 76) = 0.252$, $p = 0.66$. Finally, participants played an

average of 17.14 levels (SD = 3.14) in the silent condition and 16.99 levels (SD = 1.83) in conditions with music. No statistically significant differences were found between average number of levels played for silent and music conditions, $F(1, 76) = 0.287$, $p = 0.59$.

Overall mouse movements were also analyzed and are a sum of mouse movements to actionable items in the kitchen (to ingredients on stations), in-actionable items in the kitchen (stations where there are no ingredients), and transitions of moving the mouse across the kitchen and countertop boundary (see Table 7).

Table 7. Summary of participant mouse actions by silent or music conditions

		Mean	*SD*	*Max*	*Min*
Total mouse movements					
	Silence	99.76	11.06	133.18	77.00
	Music	102.82	12.41	136.50	78.02
To actionable items					
	Silence	31.00	4.26	42.67	22.75
	Music	31.86	3.98	40.74	25.22
To in-actionable items					
	Silence	21.91	4.15	36.27	9.67
	Music	23.28	3.68	33.67	15.98
Transitions					
	Silence	24.90	2.58	31.33	19.27
	Music	25.58	2.44	30.92	20.24
Clicks					
	Silence	30.91	2.15	37.33	24.58
	Music	31.19	1.60	35.62	27.92

Three statistically significant differences were found between silent and music conditions for mousing behavior (see Table 8). The first is for the combined types of mouse movements (total mouse movements), with more mouse movements in conditions with music than in the silent condition, $t(77) = -2.40$, $p = 0.02$. The second and third

differences were more mouse movements in the music conditions for two types of movements: movements to in-actionable items, t (77) = -2.58, p = 0.01, and transitions between the kitchen and the counter, t (77) = -2.45, p = 0.02.

Table 8. Mouse movement ANOVA results for silent and music conditions

	df	F	η	p
Total mouse movements	1	5.70	365.46	0.02*
To actionable items	1	3.12	28.86	0.08
To inactionable items	1	6.56	73.45	0.01**
Transitions	1	5.94	17.87	0.02*
Mouse clicks	1	0.94	3	0.33

*Significant at p < 0.05
**Significant at p < 0.01

Music and flow

Overall reported flow scores were moderate with an average of 3.54 (SD = 0.46) out of 5 for silence, and 3.63 (SD = 0.38) for conditions with music (see Table 9). Overall flow scores were not found to be statistically significantly different among the four conditions, F (3, 225) = 2.17, p = 0.09. Additionally, there were no statistically significant differences for overall flow scores by level of extraversion, F (1, 75) = 1.335, p = 0.25.

Table 9. Flow subscale scores for silence and music conditions (out of 5 Likert points, n = 78)

	Minimum	Maximum	Mean	Std. Deviation
Total flow - silence	2.58	4.64	3.54	.46
Total flow - music	2.75	4.46	3.63	.38
Challenge-Skill Balance - silence	1.75	5.00	3.66	.69
Challenge-Skill Balance - music	2.17	5.00	3.74	.56
Action-Awareness Merge - silence	1.25	5.00	3.18	.89
Action-Awareness Merge - music	1.75	4.67	3.25	.70
Clear Goals - silence	2.25	5.00	4.07	.66
Clear Goals - music	1.83	5.00	4.12	.62
Unambiguous Feedback - silence	1.75	5.00	3.73	.76
Unambiguous Feedback - music	2.25	5.00	3.77	.66
Concentration at Task - silence	2.00	5.00	3.86	.81
Concentration at Task - music	2.50	5.00	4.07	.58
Sense of Control - silence	1.75	5.00	3.76	.67
Sense of Control - music	2.25	5.00	3.78	.60
Loss of Self-Consciousness - silence	2.00	5.00	3.86	.77
Loss of Self-Consciousness - music	1.92	5.00	3.77	.75
Transformation of Time - silence	1.00	4.75	2.88	.90
Transformation of Time - music	1.00	4.50	3.05	.84
Autotelic Experience - silence	1.00	4.75	2.99	.92
Autotelic Experience - music	1.33	4.67	3.15	.84

Testing the hypothesis that flow scores would be higher in conditions with music over silence, a statistically significant difference was found (see Table 10), $F (1, 76) = 6.50$, $p = 0.01$. Higher overall flow scores were reported in music conditions than in silence $t (77) = -2.57$, $p = 0.01$.

Table 10. Flow subscale ANOVA results for music conditions

	df	F	η	p
Challenge-Skill Balance	1	1.31	0.13	0.26
Action-Awareness Merge	1	0.97	0.24	0.33
Clear Goals	1	0.75	0.08	0.39
Unambiguous Feedback	1	0.48	0.68	0.49
Concentration at Task	1	7.14	1.86	0.01**
Sense of Control	1	0.09	0.01	0.77
Loss of Self-Consciousness	1	2.12	0.31	0.15
Transformation of Time	1	5.22	1.13	0.03*
Autotelic Experience	1	5.25	0.94	0.03*
Overall	1	6.5	0.35	0.01**

*Significant at p < 0.05
**Significant at p < 0.01

Of the nine flow sub-scales, six were not found to be statistically significant between the silence and music conditions: Challenge-Skill Balance, Action-Awareness Merge, Clear Goals, Unambiguous Feedback, Sense of Control, and Loss of Self-Consciousness. The three subscales that were found to be statistically significant were Concentration at Task, Transformation of Time, and Autotelic Experience.

One interaction between music and level of extraversion was found for the subscale of Concentration at Task, $F(1, 76) = 6.63$, $p = 0.01$.

Grounded theory analysis

A modified grounded theory analysis (Martin & Turner, 1986) was conducted on the five of the exit questionnaire's questions regarding playing the game with music (see Table 11). By this method, similar kinds of words reported by participants were grouped into themes. These themes were counted and separated by question and by extraversion type.

Table 11. Grounded theory analysis for exit questionnaire

Question #

1	What did you enjoy *most* about the music playing during the video game and why?
2	What did you enjoy *least* about the music playing during the video game and why?
3	Would you prefer to play this video game in silence or with music? Why?
4	Do you think music helped you play the video game? Why or why not?
6	Did the music make it easier or harder to play the video game? Why?
10	What kind of music do you think would work well in this video game? Why?
11	Do you have any suggestions as to how the music in the game can be improved?

Five main themes arose from these questions and included Attention, Musical Styling, Time-Keeping, Immersion, and Emotional Regulation (see Table 12).

Table 12. Five main themes arising from grounded theory analysis

Ground theory analysis - exit questionnare

Theme	Example statement
Attention	Focused my attention on the game
Musical Styling	Music was energetic and fit the mood for the game, felt like dancing
Time-Keeping	Liked the music beat to help keep track and pace with time
Immersion	Made me feel like a real cook!
Emotional Regulation	Felt tense, but music helped distract from my anxiety, calmed me during breaks

CHAPTER 4

DISCUSSION

4.1 Effects of music

Game play performance

Though the music conditions were hypothesized to produce a cognitive effect

influencing game performance, this study's results did not support this prediction. At the

least, it was expected that conditions with music (as compared to silence) would have

resulted in higher game play scores by the arousal-mood hypothesis. This would have

been expected particularly because the songs in this study were of major key and major

mode has been shown to positively impact spatial reasoning performance (Husain et al.,

2002).

This lack of effect calls in to question whether the difficulty progression of the

level design was appropriate. *Food for Thought* creates two indices that describe how

challenging a level is to complete: complexity and difficulty. Complexity takes into

account how many steps there are per ingredient, how many mini-games there are, and

how many open kitchen stations there are to handle those steps (e.g., lots of steps and

mini-games but fewer kitchen stations would be very complex). The difficulty index

considers how forgiving the scoring is for error and how many steps must be completed

in regards to the time pressure (e.g., lots of steps and not a lot of time, not much room for

error would be very difficult). The levels in this study were designed such that the two

indices were roughly equal and advanced at a linear rate throughout the study.

One explanation for the independent variable not affecting performance is if the

level challenge did not match the player's level of skill over time. If, for example, the

game's difficulty outpaced the improving skill of the player, then the results should show

a decline in player performance over time. Conversely, if the player's skill development

outpaced the difficulty ramping of the game, then we should expect to see player

performance improving over time. Instead, through the regression analysis conducted

above, the results indicate that perhaps level difficulty progression was appropriate as

levels binned by time were not a good predictor of player performance.

Perhaps the music conditions did not precipitate an effect because of the cognitive

demands placed by the game. Many of the cognitive tasks in the music psychology

literature that are negatively impacted by music rely on the phonological loop of working

memory. As discussed previously, faster music tempos have been shown to negatively

impact mental arithmetic, free recall, and verbal comprehension task performances

(Furnham & Stephenson, 2007). *Food for Thought* has very little text to read and requires

little reading comprehension to play the game. Perhaps the cognitive demands placed on

the player by the tempo information load were of no consequence to game play

performance because they did not impinge on this part of the executive control function.

A future iteration of *Food for Thought* to test this hypothesis should include

memory games where a player would need to recruit either, or both, the phonological

loop and visuospatial sketchpad. For example, having to remember how much time an

ingredient had to cook without visual feedback or a simple card sorting memory game of

paired recipes.

Game play behavior

The music conditions also did not have an effect on the durations spent in the

three game stages of planning, playing, and reviewing. As well, there was no main effect

found for level of extraversion on these variables. That fits with a previous *Food for Thought* study examining correlations between BFI-44 dimensions and these game stages (Levy, et al, 2015). Though some participants had written in the exit questionnaire that they used the planning and reviewing times between levels to rest, there were no statistically significant differences between music conditions or level of extraversion for these times.

The number and kind of mouse movements was found to be different between the silence and music conditions. In conditions with music, participants made more total mouse movements overall. Overall mouse movements are a sum of the three kinds of mouse movements that can be made in the game: 1) to actionable items (ingredients on stations), 2) to in-actionable items (to stations without ingredients), and 3) transitions (crossing the kitchen and countertop threshold). Of those overall mouse movements, the results indicate that there were more motions to in-actionable stations and transitions. The excess of these two kinds of mouse movements suggest inefficient motions that do not necessarily contribute to game play or performance. Players were moving to and across areas that had no direct association to solving the challenges of the game. Additionally, many participants (both introvert and extraverts) cited that the music beat made them want to work faster and time their motions with the music.

Many authors have suggested that humans are predisposed to time motor actions with musical beats (Karageorghis, Terry, & Lane, 1999; Large, 2000). Sports research, in particular, has investigated how athletes might time their physical movements to music in order to have increased gains in their sport. A famous example of this was when Haile Gebrselassie beat the world record for an indoor running race while synchronizing his

footfalls with the music playing over the stadium's speaker system (Karageorghis et al., 2010). Other positive effects of music on physical exertion have also been demonstrated in running (Simpson & Karageorghis, 2006), walking on treadmills (Karageorghis et al., 2009), aerobic bench stepping (Hayakawa, Miki, Takada, & Tanaka, 2000), and cycling (Anshel & Marisi, 1978). A study by Roballey et al. (1985) found that people listening to fast tempo music unknowingly took more bites per minute, though the total time to eat the meal was unaffected.

With the wealth of knowledge that exists for how music affects more active kinds of physical motions, it seems not an unreasonable conclusion to draw that music in a video game would affect hand motor movement. The results showing that it is mouse movements not directly linked to playing the game further support this hypothesis. Similar to this study, Konz and Mcdougal (1968) found that playing fast music in a driving simulator results in more steering wheel movements. These extra steering wheel movements were not necessary for operation.

Flow

As hypothesized, higher overall flow scores were reported in conditions with music as compared to silence. There was no difference found in flow scores between introverts and extraverts, suggesting they both experienced overall flow in similar ways. To date, most studies using the flow scale in music psychology studies are investigating experiences of flow in people creating music, as in playing with an orchestra (Bakker, 2005; Fritz & Avsec, 2007; MacDonald, Byrne, & Carlton, 2006). This author could find no published studies where the flow scale had been used to assess experience by people casually listening to music. However, as previously discussed in the Introduction, there is

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evidence that music enhances game experience and results in higher feelings of immersion (Grimshaw et al., 2008; Nacke et al., 2010; Zehnder & Lipscomb, 2006). To further understand what elements of flow contributed to the difference in overall experience, the subscales were analyzed for silent and music conditions.

The flow subscale of Concentration at Task was found to be higher in conditions with music than those without. From the grounded theory analysis, participants directly stated that the music (particularly the beat) helped them keep focus. Smith (1961) suggested that music has the ability to reduce boredom and make tedious jobs, such as those in factories, more appealing. In fact, participants in the exit questionnaire cited that playing with music was "less boring" than playing in silence. *Food for Thought* was not designed to be played for the lengths of time used in this study. In a previous study, participants reported that they would prefer to play the game between 20 and 30 minutes (Levy et al., 2015). In this study, participants played for much longer and the experience of completing recipe after recipe likely became monotonous for them. As suggested by (Fox, 1971), music can make repetitive tasks seem less dull by raising levels of arousal and alertness. Interesting elements in the music playlists during the game might have reduced the tedium of playing a game that was originally designed to be played in shorter rounds.

There was a main effect for extraversion and Concentration at Task, with extraverts reporting higher Concentration scores as compared to introverts independent of the experimental variable of music condition. Though the current literature is unclear as to whether extraverts perform better at multitasking, there is some evidence that suggests that extraverts prefer polychronicity (doing multiple tasks at once) (Konig et al., 2005;

Lieberman & Rosenthal, 2001). Perhaps the environment of the study as a whole (multitasking on the game, experience of being in a study) more appropriately matched the threshold of arousal preferred by extraverts and they, therefore, felt they could concentrate better at the task at hand.

The Transformation of Time flow subscale describes a feeling of time passing more quickly, more slowly, or a complete unawareness of the passage of time (Jackson & Marsh, 1996). Measures in this subscale were found to be higher in conditions with music, as compared to silence, meaning that participants felt time was altered in some way while playing the game with music. The exit questionnaire reveals that participants most often stated that the music made time seem to pass faster, in an enjoyable way. A study by Newman Jr, Hunt, and Rhodes (1966) found that all workers in a skateboard factory reported feeling time passed faster when music was played during their work. Some participants in the present study noted that they used the songs to "keep pace with time" by counting how many songs had played and estimating their length of time within the 30-minute play bout. There was no difference between introverts and extraverts for this subscale, suggesting they experienced time transformation in similar ways.

Finally, the flow subscale of Autotelic Experience was found to be higher in conditions with music than the silent condition. This subscale describes the outcome of being in flow where the activity is rewarding for its own sake and there is no want for outside profit or reward (Csikszentmihalyi, 1990). Results from the grounded theory analysis support the findings in increased Autotelic Experience flow scores. Common definitions of flow contain three main elements: enjoyment, absorption, and intrinsic motivation (Csikszentmihalyi, 1997; Csikszentmihalyi & Csikszentmihalyi, 1992).

Indeed, participants used even some of these same words stating that playing the game with music was more immersive, enjoyable, engrossing, and rewarding.

Qualitative statements on exit questionnaire

Equal numbers of extraverts and introverts reported that the music helped them play the game. The reasons cited for how the music helped were different by personality type, however. Both extraverts and introverts stated that music helped focus their attention, but in different ways. Extraverts reported that music focused their attention on the game, while introverts reported music focused their attention away from their external environment. Introverts were also the only ones to report that music helped keep their focus off of mistakes they had made and mentioned that the music made it "more difficult to multitask". Two extraverts noted that the music became distracting if it was "too good" and they "had to dance to it".

In terms of Musical Styling, introverts reported that they liked "relaxing" and "soothing" songs that played during their sessions. On the other hand, extraverts used more rousing words to describe what they liked about the music, such as "exciting", "energetic", and "funky". Similarly, when asked what kinds of music they thought would work well in *Food for Thought*, introverts stated they would prefer "calm" and "ambient" music while extraverts preferred "fast-paced" genres.

Both personality types wrote that they enjoyed having a musical beat to play the game to. Both introverts and extraverts reported the beat made them "want to play faster", coordinate their movements to the tempo, and that it helped them "keep pace in time". Both types felt that musical rhythm "fit the game", "made it more fun" and "set the tone for goals". Equal numbers of participants from the personality types stated that the

music enhanced their experience of the game, increasing immersion, aiding in a sense of "becoming engrossed", and made the experience rewarding. Participants stated that this increased immersion came from "feeling like a real cook, top of the world!" and gave a structure to what they were doing. Participants reported that the music gave them a feeling of importance and control.

Finally, music served an emotional regulation purpose, particularly for introverts. Introverts described the music helping them "calm down from the anxiety of the game" and that it kept them from becoming overly anxious or stressed.

CHAPTER 5

CONCLUSION

Music has the capability to exert a great effect over human cognitive, physical, and emotional events. Our proclivity to create, consume, and move to music has inspired nearly 200 years of music psychology research. It is only fairly recently that we are beginning to understand the mechanisms and magnitude of music's influence on us. A nascent area of research in this domain is regards to music's effects in popular media.

Game designers and companies seek to create the most rewarding play experience by employing a variety of mechanics and adjustable algorithms to tailor the game play to specific player types. What is under-utilized is dynamic adjustment of music. With all that is known for how music affects performance, behavior, and performance in other fields, it would not be surprising to find that music affects similar variables within a game.

Game algorithms that assess player type through player behavior are becoming more pervasive in commercial games. These games change the play experience to match the needs of the player. Continuing our understanding of how music and individual differences work together in a game experience could inform how these algorithms should behave.

The design of therapeutic games that both challenge and reward the player is very difficult. Music is rarely used as a motivating tool in therapeutic games, though doing so would likely create a more engaging and positive experience. For cognitive training video games in particular, there is often a need to push the player past their comfort level so that they work through some requisite difficulty in order to experience cognitive benefit

(Koriat & Bjork, 2005). Usually, therapeutic games employ more difficult levels to push the player but these harder levels usually frustrate an already disadvantaged person. Perhaps altering game music variables could be a more useful way to increase difficulty and arousal in a player. This could result in games, both commercial and therapeutic, that are more engaging, fun, and challenging in the right ways.

Understanding music's effects on our physical behavior could also work to the advantage of serious games. Many physical therapy games involve monotonous tasks like sorting socks and continuously reaching for a ball (Alankus, 2011) . Though the biggest issue with these games is their un-engaging design, the addition of music could go a long way in motivating a participant and unconsciously compelling them to move more and in rhythmic ways. An added sense of time passing faster, higher concentration, and an overall sense of inner reward could be a boon to a field of games designed to make people's lives better.

CONSENT FORM

CONSENT DOCUMENT FOR ENROLLING ADULT PARTICIPANTS IN A RESEARCH STUDY

Georgia Institute of Technology
Project Title: **Video Game Study**

Investigator: Dr. Maribeth Gandy Coleman
You are being asked to be a volunteer in a research study.

Purpose:
The purpose of this study is to understand how different video game elements may impact your play experience. We also want to understand what you think of a new kind of video game. Your participation in the study is completely voluntary. You may quit at any time during the study if you want to. We expect to include approximately 80 people in the final study.

Exclusion/Inclusion Criteria:
In this study we will be including English-speaking participants between the ages of 18 and 40.

Procedures:
This study is organized into two stages: the screening stage and final study.

If you decide to be in this study, you will be asked to take an online personality assessment. This assessment takes about 30 minutes to complete. Participants from Georgia Tech who complete this assessment will receive 0.5 credits for their time. Participants from the general population will not receive compensation for this portion of the study.

We will be selecting certain scores from the personality assessment and these participants will be included in the final study. Not everyone will be able to participate in the final study. If you are included, we will contact you and thank you for your participation. You will be asked to schedule an appointment for your first session. If you are not included, we will contact you to let you know and your commitment to the study will be completed.

If you are included and choose to participate in the study, you will be asked to take a few surveys during the study. You will also be scheduled for two sessions each lasting no more than two hours that works with your schedule. During these sessions, you will be asked to play a computer game called *Food for Thought*.   Your participation for this part of the study will involve 4 hours total time. Participants from Georgia Tech will receive 4 class credits for this stage of the study. KSU Marietta Campus students have the option to receive extra credit, as determined by your adviser. Participants from the general population will receive $20 for completion of the study.

These sessions will take place at Georgia Tech or KSU Marietta Campus. You may stop at any time for any reason.

Risks or Discomforts:
Participation in this study involves minimal risk or discomfort to you. Risks are minimal and are not more than those associated with playing normal commercial video games. If at any time during the study you feel uncomfortable and want to stop, you are free to do so. Please tell us if you are having trouble with any task.

Benefits:
You are not likely to benefit in any way from joining this study.

Compensation to You:
Participants from Georgia Tech that complete the personality assessment will receive 0.5 class credits. Participants from the general population will not receive compensation for this portion of the study.

If you are selected for the final study, then Georgia Tech students will have the opportunity to earn 4 class credits for completing the study. The maximum number of class credits Georgia Tech students may earn in this study is 4.5 credits. KSU Marietta Campus students may earn extra credit for completion of the study, as determined by your advisor. Participant from the general population will receive $20 for completion of the study. If you decide to withdraw from the study early, you will receive a portion of credits or pay corresponding to the amount of time you spent in the study.

Confidentiality:
The following procedures will help to keep your personal information as confidential as possible in this study:
The data collected about you will be kept private to the extent allowed by law. Your records will be kept under a code number instead of a name to protect your privacy. Your records will be kept in locked file cabinets and on a password protected file server. Only study staff will be allowed to look at them. Your name and any other fact that might identify you will not appear when results of this study are presented or published. Your privacy will be protected to the extent allowed by law. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Office of Human Research Protections may also look over study records during required reviews.

Costs to You:
Other than your time, there are no costs to you for being in this study.

In Case of Injury/Harm:
If you are injured as a result of being in this study, please contact Principal Investigator, Maribeth Gandy, at telephone (404) 894-3638. Neither the Principal Investigator nor Georgia Institute of Technology has made provision for payment of costs for any injury due to participation in this study.

Participant Rights:
- Your participation in this study is voluntary. You do not have to be in this study if you don't want to.
- You have the right to change your mind and leave the study at any time. You do not have to give a reason for wanting to leave. There would be no penalty to leaving.
- Any new information that may make you change your mind about being in this study will be given to you.
- You will be given a copy of this consent form to keep.
- You do not waive any of your legal rights by signing this consent form.

Questions about the Study:
If you have any questions about the study, you may contact Maribeth Gandy at telephone (404) 894-3638 or email maribeth.gandy@imtc.gatech.edu.

Questions about Your Rights as a Research Participant:
If you have any questions about your rights as a research participant, you may contact

Ms. Melanie Clark, Georgia Institute of Technology Office of Research Integrity Assurance, at (404) 894-6942.

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

_____

Participant Name (printed)

_____   _____

Participant Signature   Date

_____   _____

Signature of Person Obtaining Consent   Date

PRE-QUESTIONNAIRE

Please answer the following questions. All of your answers will be treated confidentially. If you have any questions during the survey, please let an experimenter know and we would be happy to help. If there is a question you do not wish to answer, you may leave it blank and go on to the next question.

Date of Birth (DD/MM/YYYY): _____/_____/_____

Education <u>completed</u> (check highest level completed):
5   Less than high school graduate
6   High school graduate/GED
7   Some college, trade, technical, or business school (please write number of years)_____
8   Bachelor's degree
9   Some graduate work (please write number of years)_____
10 Master's degree
11 MD, JD, PhD, or other advanced degree
12 Other (if other, write education completed)_____

Current marital status:
◊   Single
◊   Married
◊   Separated
◊   Divorced
◊   Widowed
◊   Other _____

What is your primary language?
◊ English
◊ Spanish
◊ French
◊ Other _____

Race/ethnicity:
◊ Black/African American
◊ Asian American/Pacific Islander
◊ White/Caucasian
◊ Hispanic/Latino
◊ American Indian/Alaskan Native
◊ Multiracial
◊ Other _____

Student status:
◊ Full time student
◊ Part time student

For the next section of questions, please indicate how much you agree with or disagree with each statement. (Circle one answer)

I feel comfortable with video games.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Learning about video games is a worthwhile and necessary subject.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Video games turn people into just another number.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

The use of video games is lowering our standard of living.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Video games control too much of our world today.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Reading or hearing about video games would be (is) boring.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

I know that if I worked hard to learn about video games, I could do well.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Video games make me nervous.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Life will be (is) harder with video games.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

I don't care to know more about video games.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

Video games would be (are) fun to use.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

I don't feel confident about my ability to play a video game.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

Everyone could get along just fine without video games.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

Video games are dehumanizing.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

Video games are NOT too complicated for me to understand.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

I think I am the kind of person who would learn to play a video game well.

Strongly   Disagree   Neither   Agree   Strongly
Disagree   Agree nor   Agree
                                    Disagree

It is NOT necessary for people to know about video games in today's society.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Video games are too fast.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Learning about video games is a waste of time.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Video games are confusing.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Video games make me feel dumb.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

Given a little time and training, I know I could learn to play a video game.

| Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |

For the following questions, indicate how often you use each computer program, or how often you use a computer for each activity.

How often do you use the following programs? (Circle one answer)

Word processing (e.g., Word)

Never   Rarely   Sometimes   Often   Very Often

Spreadsheets (e.g., Excel)

Never   Rarely   Sometimes   Often   Very Often

Presentation programs (e.g., Powerpoint)

Never   Rarely   Sometimes   Often   Very Often

Programming language (e.g., Java)

Never   Rarely   Sometimes   Often   Very Often

Graphics Software (e.g., Illustrator)

Never   Rarely   Sometimes   Often   Very Often

Sound or video editing software

Never   Rarely   Sometimes   Often   Very Often

E-mail client (e.g., Outlook)

Never   Rarely   Sometimes   Often   Very Often

Chat program (e.g., IRC, Skype)

Never   Rarely   Sometimes   Often   Very Often

Web browser (e.g., Firefox, Internet Explorer)

Never   Rarely   Sometimes   Often   Very Often

Games (e.g., The Sims)

Never   Rarely   Sometimes   Often   Very Often

How often do you perform the following computer activities? (Circle one answer)

Creating a presentation

Never   Rarely   Sometimes   Often   Very Often

Programming

Never   Rarely   Sometimes   Often   Very Often

Sound editing

Never   Rarely   Sometimes   Often   Very Often
Writing e-mails

Never   Rarely   Sometimes   Often   Very Often

Chatting

Never   Rarely   Sometimes   Often   Very Often

Surfing the web

Never   Rarely   Sometimes   Often   Very Often

Playing computer games alone

Never   Rarely   Sometimes   Often   Very Often

Playing computer games online

Never   Rarely   Sometimes   Often   Very Often

Please indicate the extent to which you have experienced the following emotions in the **last 24 hours** by checking the appropriate box.

Interested
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Distressed
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Excited
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Upset
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Strong
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Guilty
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Scared
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Hostile
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Enthusiastic
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Proud
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Irritable
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Alert
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Ashamed
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Inspired
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Nervous
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Determined
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Attentive
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Jittery
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Active
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

Afraid
Not at all [ ]   A Little [ ]   Moderately [ ]   Quite a bit [ ]   Very much [ ]

BIG-FIVE INVENTORY 44-ITEM

The Big Five Inventory (BFI)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who <u>likes to spend time with others</u>? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

Disagree strongly	Disagree a little	Neither agree nor disagree	Agree a little	Agree strongly
1	2	3	4	5

<u>I see Myself as Someone Who</u>...

____1. Is talkative

____2. Tends to find fault with others

____3. Does a thorough job

____4. Is depressed, blue

____5. Is original, comes up with new ideas

____6. Is reserved

____7. Is helpful and unselfish with others

____8. Can be somewhat careless

____9. Is relaxed, handles stress well

____10. Is curious about many different things

____11. Is full of energy

____12. Starts quarrels with others

____13. Is a reliable worker

____14. Can be tense

____15. Is ingenious, a deep thinker

____16. Generates a lot of enthusiasm

____17. Has a forgiving nature

____18. Tends to be disorganized

____19. Worries a lot

____20. Has an active imagination

____21. Tends to be quiet

____22. Is generally trusting

____23. Tends to be lazy

____24. Is emotionally stable, not easily upset

____25. Is inventive

____26. Has an assertive personality

____27. Can be cold and aloof

____28. Perseveres until the task is finished

____29. Can be moody

____30. Values artistic, aesthetic experiences

____31. Is sometimes shy, inhibited

____32. Is considerate and kind to almost everyone

____33. Does things efficiently

____34. Remains calm in tense situations

____35. Prefers work that is routine

____36. Is outgoing, sociable

____37. Is sometimes rude to others

____38. Makes plans and follows through with them

____39. Gets nervous easily

____40. Likes to reflect, play with ideas

____41. Has few artistic interests

____42. Likes to cooperate with others

____43. Is easily distracted

____44. Is sophisticated in art, music, or literature

<u>Please check: Did you write a number in front of each statement?</u>

FLOW QUESTIONNAIRE

ID Number: _____

Think about how you felt while playing *Food for Thought*:

1. I was challenged, but I believed my skills would allow me to meet the challenge.

| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

2. I made the correct movements without thinking about trying to do so.

| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

3. I knew clearly what I wanted to do.

| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

4. It was really clear to me that I was doing well.

| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

5. My attention was focused entirely on what I was doing.

| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

6. I felt in total control of what I was doing.

| Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree |

7. I was not concerned with what others may have been thinking of me.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

8. Time seemed to alter (either slowed down or speeded up).

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

9. I really enjoyed the experience.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

10. My abilities matched the high challenge of the situation.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

11. Things just seemed to be happening automatically.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

12. I had a strong sense of what I wanted to do.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

13. I was aware of how well I was performing.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

14. It was no effort to keep my mind on what was happening.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

15. I felt like I could control what I was doing.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

16. I was not worried about my performance.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

17. The way time passed seemed to be different from normal.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

18. I loved the feeling of that performance and want to capture it again.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

19. I felt I was competent enough to meet the high demands of the situation.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

20. I performed automatically.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

21. I knew what I wanted to achieve.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

22. I had a good idea while I was performing about how well I was doing.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

23. I had total concentration.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

24. I had a feeling of total control.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

25. I was not concerned with how I was presenting myself.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

26. It felt like time stopped while I was performing.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

27. The experience left me feeling great.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

28. The challenge and my skills were at an equally high level.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

29. I did things spontaneously and automatically without having to think.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

30. My goals were clearly defined.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

31. I could tell by the way I was performing how well I was doing.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

32. I was completely focused on the task at hand.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

33. I felt in total control of my body.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

34. I was not worried about what others may have been thinking of me.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

35. At times, it almost seemed like things were happening in slow motion.

Strongly   Disagree   Neither agree   Agree   Strongly
disagree   nor disagree   agree

36. I found the experience extremely rewarding.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

EXIT QUESTIONNAIRE

For the following questions, please write as much as you want to answer the question.

What did you enjoy *most* about the music playing during the video game and why?

What did you enjoy *least* about the music playing during the video game and why?

Would you prefer to play this video game in silence or with music? Why?

Do you think music helped you play the video game? Why or why not?

What did you find easy or difficult about playing the game?

Did the music make it easier or harder to play the video game? Why?

What was the most difficult part of the video game?

What was the easiest part of playing the video game?

What did you find most difficult about playing the video game overall?

What kind of music do you think would work well in this video game? Why?

Do you have any suggestions as to how the music in the game can be improved?

Is there anything else you want to tell us about your experience with the video game or with the study?

Which musical styles do you choose to listen to on a daily/regular basis?

Please check all that apply.

◊ Pop

◊ Gospel

◊ Baroque (classical)

◊ Electronic/dance

◊ World

◊ Rap

◊ R&B

◊ Indie

◊ Symphonic

◊ Classical (classical)

◊ Country

◊ Punk

◊ Folk

◊ 20th/21st century (classical)

◊ Rock

◊ Chamber Music

◊ Choral

◊ Piano (classical)

◊ Alternative

◊ Blues

◊ Acoustic

◊ Hip-Hop

◊ Heavy Metal

◊ Romantic (classical)

◊ Jazz

◊ Other _____

◊ Other _____

◊ Other _____

For the following items, please indicate your basic preference level for the genres listed using the scale provided.

1----------2-----------3------------4------------5------------6-------------7

Strongly dislike   Neither like   Strongly like
                           nor dislike

1. _____ Classical

2. _____ Blues

3. _____ Country

4. _____ Dance/Electronica

5. _____ Folk

6. _____ Rap/hip-hop

7. _____ Soul/funk

8. _____ Religious

Do you currently play video games?

YES   NO

If yes, please think of the five video games that you have played for the greatest amount of time from when you were in 7th grade until the present. Include computer, phone/mobile, console/TV, and arcade games. Please write down the titles of these games on the blank lines below.

Title of your "most played" game: _____
Title of your "2nd most played" game: _____
Title of your "3rd most played" game: _____
Title of your "4th most played" game: _____
Title of your "5th most played" game: _____

Please select any and all game genres you like to play:
- Action
- Adventure
- Arcade
- Casual
- Fighting
- First person shooter
- Flight
- Massively multiplayer
- Music
- Party
- Platform
- Puzzle
- Racing
- Real time strategy
- Shooting
- Simulation
- Sports
- Strategy
- Third person shooter
- Turn-based strategy
- Wargame
- Other_____
- Other_____

How often do you play video games?
- Never
- Rarely
- Sometimes
- Often

How many hours **per week** would you estimate that you play video games? This includes mobile/phone games.
- 0-2 hours
- 2-5 hours
- 5-8 hours
- 8-10 hours
- 10-15 hours
- 15-20 hours
- 20+ hours

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