THE EFFECT OF MUSIC ON IMPULSIVITY IN COLLEGE UNDERGRADUATE STUDENTS WITH ATTENTION DEFICITS

by

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This dissertation is dedicated to my children, Logan and Samantha. This degree was one of my dreams. Know that I will always be there to support you as you work toward your dreams. I love you both.

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ABSTRACT

The purpose of this study was to investigate the effect of music listening on impulsivity as judged by the Conners' Continuous Performance Test (CPT) II v. 5. College undergraduate students were recruited into one of two groups and were administered a computer task (CPT) to complete in an initial condition, a music condition, and a silence condition. One group of participants had no diagnosed history of ADHD while the other participant group had a history of ADHD. The initial condition served as an opportunity for each participant to take the CPT with the researcher present to allow each participant to ask questions before taking the test alone; each participant was then taken to a separate testing room. As all participants were tested in all three conditions, the remaining two (music and silence) were randomly assigned to control for order effect. The music condition involved taking the CPT alone in the testing room with "In a Mello Tone" by Count Basie playing in the background during the test administration. The piece was manipulated to have a tempo of mm = 124 and looped to last the entirety of the CPT (14 minutes). Each participant was administered the CPT in a silence condition, in which the participant was alone in the testing room without other provided stimuli.

The final sample was $N = 51$ with $n = 26$ enrolled in the typical group and $n = 25$ enrolled in the group with attention deficits. A significant main effect difference was found by group: the typical group exhibited lower impulsivity levels as compared to the ADHD group based on Commission mean scores. Additionally, significant main effect differences were found by condition (initial, music, and silence). Both the factors of group and condition appear to be independent as no interaction was found. Implications and suggestions for future research were discussed.

CHAPTER 1: INTRODUCTION

> In the modern Western world, where music is readily available to everyone through radio, recordings, TV and videos and where recorded background music is routinely played in many public places, the need to understand the effects of music on our behaviour and cognitive processing has become increasingly important. (Hallam, Price, & Katsarou, 2002, p. 111)

People may not realize how listening to background music impacts their life. Listening to background music while completing a variety of activities is common, and individuals often do not realize the potential benefits of music listening when performing certain tasks. Sacks (2007) stated that "musicophilia," or a partiality to music, is part of the human condition that encompasses our entire being including senses, emotions, and muscles regardless of conscious attention to the music itself (p. x-xi). While research has been conducted investigating the benefits of background music use overall, the number of studies conducted pertaining to the effects of music on individual activity remains sparse (Kämpfe, Sedlmeier, & Renkewitz, 2011). This is especially true among specialized populations, such as students with attention deficits.

Researchers have conducted initial research into the benefits of background music on learning among students with attention deficits (Abikoff, Courtney, Szeibel, & Koplewicz, 1996; Cripe, 1986; Klien, 1981; Pratt, Abel, & Skidmore, 1995; Scott, 1970); however, such findings are preliminary at best and need additional research support. More systematic investigation is needed to support those primary findings of background music's positive effects on learning among individuals with unique and varied characteristics, specifically those with attention deficit disorders. The preliminary research, although promising, requires further exploration to determine the consistency of such findings under controlled, experimental study conditions.

Background Music Use by the General Population

Although the effects of background music have been the focus of numerous researchers, the global effect for background music in typical adults is insignificant when comparing effect sizes (see Kämpfe et al, 2011 for studies compared). Kämpfe et al. (2011) completed a meta-analysis of studies involving the effects of background music in adults, specifically those calculating effect sizes. The authors found a negative effect on individuals' reading tasks and memory but a positive effect on emotion and sports achievement. Tempo was found to affect the speed of activity while background music was present. Despite the lack of global effect, "…music is assumed to have a positive impact on performance and there is indeed evidence for this view in the research literature" (Kämpfe et al., 2011, p. 425); hence, background music is used frequently for marketing purposes.

The use and marketing of background music has become a lucrative business, and many associate the word "Muzak" with music played in elevators, offices, shops, and restaurants. The brand Muzak first appeared in 1934 (Sisario, 2013). Mood Media, a company reportedly reaching 150 million people per day with their various products through what is called "sensory marketing," purchased Muzak in 2011 for $345 million and dropped the Muzak label in favor of the brand name "Mood." The music portion of this new brand accounts for approximately 90% of all sales, which equates to $32 million in gross earnings in the third quarter alone (Sisario, 2013). Purchasing background music has become a business expense bolstered by research that purports beneficial effects from its use. Music is a "relatively inexpensive" way to manipulate an environment while being easy to change and has a somewhat "predictable appeal to individuals based on their ages and lifestyles" (Yalch & Spangenberg, 1993, p. 632). Researchers have conducted studies utilizing background music in a wide variety of settings and populations; research areas include marketing, education, and mood enhancement.

Consumers and background music use. Researchers have found that background music has an effect on shoppers in different settings. Milliman (1982) found that slow music (mm[1] = 72 or less) significantly affected the traffic pace and sales volume as compared with fast music (mm = 94 or higher). Although no significant differences existed between the music conditions and a no music condition, traffic pace was slower in the slow music condition as compared to the no music condition. Eroglu, Machleit, and Chebat (2005) also found positive results utilizing slow background music (mm = 60); shoppers claimed a higher tendency to speak with other shoppers, browse, and purchase a snack during a slow music condition while stating a preference to avoid the mall altogether during a fast music condition (mm = 96). The researchers also reported a significant interaction between music tempo and density—the amount of people and/or objects in a space; shoppers expressed higher mean enjoyment during fast music/low density retail spaces and slow music/high density retail spaces with lower means reported in conditions of slow music/low density and fast music/high density. A similar interaction was found regarding task accomplishment (i.e. completing all purchasing tasks), with higher means in fast music/low density and slow music/high density scenarios. Vida, Obadia, and Kunz (2007) observed shoppers would shop longer and spend more based on enjoyment of background music and perceived fit of the music with the store's retail image.

Yalch and Spangenberg (1990, 1993, 2000) conducted three studies with similar results regarding music effects on retail shopping. Both shoppers under age 25 and older shoppers age 25 through 50 reported liking foreground music—defined by the authors as music with lyrics and the original artists—more than background music—studio versions of music that were entirely

[1] mm is the abbreviation for Metronome Marking, which states beats per minute.

instrumental; shoppers 50 and older preferred background music (Yalch & Spangenberg, 1990, p. 34). However, less time was spent shopping during the reported preferred music conditions with participants under age 25 shopping more with background music and participants over age 25 with foreground music (Yalch & Spangenberg, 1990). Yalch and Spangenberg (1993) found gender differences may also be a factor with males purchasing more in a foreground music condition and females purchasing more within a background music condition. In a more recent study, Yalch and Spangenberg (2000) reported shoppers spent less time shopping in a familiar music setting—primarily current popular “top 40” hits of the time, but product evaluations were more positive when exposed to familiar music as compared to unfamiliar music—instrumental versions of older songs. Participants also reported lower states of arousal when listening to unfamiliar music; “Once the effect of arousal on shopping times was considered, other reactions to music familiarity (either measured or unmeasured) did not have an effect on actual shopping times" (Yalch & Spangenberg, 2000, p. 145).

Similar shopping and/or consumption time effects were reported in restaurant settings. Milliman (1986) found people dining with slow background music (mm = 72 or less) spent significantly more time at the table and spent significantly more money on alcoholic beverages as compared to those dining with fast background music (mm = 92 or more). Caldwell and Hibbert (2002) conducted a similar study in which they used Milliman’s definitions for slow and fast music but did not choose strictly instrumental versions of recognizable songs. Although significant differences were found between tempo and musical preferences when analyzed separately with time spent in the restaurant, only musical preference emerged as significant when combined into one analysis. It was also noted that all dining satisfaction measures were significantly correlated to music preference (Caldwell & Hibbert, 2002, p. 910). Similarly, North and Hargreaves (1998) found that music genre affected sales and the atmospheric perceptions of participants in a university cafeteria. College students perceived food to cost most and were willing to spend more on items offered at the cafeteria in a classical music condition and a pop music condition as compared to silence and easy listening sound conditions.

The effect of music to alter perceived time spent in various situations has also been tested. North and Hargreaves (1999) found participants waiting for the return of a lab assistant would wait longer in a low-, medium-, or high-complexity pop music setting in comparison to a no music condition. Most participants waited the full 20 minutes in the music conditions despite being told they were not required to do so; high-complexity music lowered the reported music enjoyment of the participants, but did not cause them to leave the waiting room. All participants underestimated time left waiting with the closest estimates in the no music condition and the largest underestimations in the high-complexity condition. Oakes (2003) also reported distorted time awareness; participants waiting in the registrar's office perceived a shorter wait time in a slow music condition in waits between 4 and 15 minutes as compared to fast music and no music conditions. However, longer waits—between 15 and 25 minutes—resulted in no significant differences between conditions, with all wait times perceived as longer than actual wait times; the shortest perceived wait times were reported in the slow music condition and the largest perceived wait times reported in the no music condition. Customer satisfaction and relaxation was highest in the slow music condition for short wait times and the no music condition for long wait times. Oakes (2003) concluded that the positive effect of the music waned as wait times increased, with participants possibly associating slow music with slow service.

In a study assessing the effects of self-selected versus experimenter-selected music during a simulated driving session, Cassidy and Macdonald (2010) found participants were more accurate and enjoyed the driving experience more in a self-selected music condition as opposed to an experimenter-selected condition. Drivers were less accurate in experimenter-selected music conditions and the least accurate in high-arousal music conditions; high-arousal music was classified as such by "independent participants" (Cassidy & Macdonald, 2010, p. 457). Time perception was underestimated in self-selected music and overestimated in experimenter-selected music, with a positive correlation between time estimation and music preference.

Background music use and education. Music use while studying has been shown to be a relatively common phenomenon among students of various ages. Patton (1983) found students frequently used music and other media while studying. A large percentage of elementary and junior high students commonly studied with either television or music in the background; 24% of surveyed elementary students and 40% of junior high students reported listening to music regularly while completing math homework (p. 284). Approximately 58% of all students indicated their typical homework sessions included listening to music (p. 285). Kotsopoulou and Hallam (2010) reported that students used music to concentrate while studying. While music use was dependent upon students' mood and subject studied, students used music more while writing and thinking than during test preparation, memorization, or foreign language study (p. 436). These data are based in self-perception, and while important, do not show the effects of music's use in specific subject areas and were not collected under controlled experimental conditions.

Several researchers have studied the effect of music use on reading task achievement. Freeburne and Fleischer (1952) used five different sound conditions—silence, classical music, semi-classical music, popular music, and jazz music—to determine whether music influenced university students' reading rates and comprehension. No significant difference of music's effect on reading was found among the five groups with the exception of a faster reading rate during the playing of jazz music. Henderson, Crews, and Barlow (1945) reported mixed results when using popular music, classical music, and silence conditions while testing reading efficiency. The only significant difference was found among students during the popular music listening condition, with the participants answering more questions incorrectly after reading a paragraph while listening to popular music as compared to both a classical music and a silence condition. The authors suggested music complexity and task complexity may influence distraction levels (p. 317). Instrumental versions of show tunes (Fogelson, 1973) and hit songs as listed by Billboard Magazine (Anderson & Fuller, 2010) were found to be significant distractors on reading comprehension tests. Hall (1952), however, found reading comprehension scores increased for 58% of participants in the presence of background music with accuracy dropping during the no music conditions. Although these studies' results were mixed when examining music's effect on reading tasks, other tasks completed with background music have shown potential participant benefits.

Background music, arousal states, and physiological indicators. Background music has been shown to positively influence mood and states of arousal. Lesiuk (2010) found a significant increase in positive mood when computer information system designers were allowed to listen to their preferred music while on the job, which led to increased cognitive performance. Music preference was found to be an important factor in stress reduction; Jiang, Zhou, Rickson, and Jiang (2013) found sedative music less relaxing than preferred music. Hallam, Price, and Katsarou (2002) found primary school students, ages 10 to 12, completed significantly more math problems and were able to remember more words in a memory task when "calming" music was played in the background. These findings were similar to Stanton's (1973) results who investigated the benefits of playing classical music to high school and university students with high levels of anxiety; students with high anxiety scored significantly higher in the music condition as compared to a silence condition. However, Mowsesian and Heyer (1973) found no significant difference in math, spelling, or self-concept scores by music background conditions (rock, folk, classical instrumental, classical vocal, and a silence condition). Schellenberg, Nakata, Hunter, and Tamoto (2007) found various types of music increased arousal and mood and affected cognition and cognitive testing results. Reiber (1965) reported an increase of activity level in children ages five to six when “fast” music was played in the background during an individual play session as contrasted to children’s’ activity during the playing of “slow” music or a silence condition. Stratton and Zalanowski (1984) reported significant increases in group verbal interactions when soothing music was played in the background as opposed to stimulating music or silence conditions.

In addition to behavioral and psychological indicators, music has been found to have physiological effects. Bartlett (1996) reviewed 120 years of research to confirm “music and sound stimuli have been found to influence bodily systems” (p. 374) including, but not limited to, cardiovascular, muscular, respiratory, and integumentary (i.e. skin) systems. Of the approximately 190 hypotheses reviewed, 62% resulted in intended outcomes (i.e. decrease of muscle tension in a relaxing music condition) (Bartlett, 1996, p. 375). For example, Blanchard (1979) found playing classical or rock-and-roll music to students during an exam resulted in blood pressure and pulse rates similar to those taken before the exam was administered. Blood pressures and pulse rates were significantly lower for students in the experimental groups shortly after the end of the exam; students in the control group scored significantly lower on the exam than either music group. Lai et al. (2008) found similar results with nursing students. Participants were given examinations in either music or silence settings; those in the music condition experienced lower test anxiety and lower state of anxiety as evidenced by higher finger temperatures and lower pulse rates than those in the silence condition. These effects were further substantiated by Thoma et al. (2013) who found listening to relaxing music prior to a stressor helped the autonomous nervous system recover more efficiently and increased activation of the hypothalamus-pituitary-adrenal (HPA) axis; the HPA is responsible for releasing cortisol—a stress hormone. Despite these promising results, very few studies have been replicated to "substantiate selected behavioral patterns" (Bartlett, 1996, p. 375).

As shown in the preceding brief literature overview, the effects of music on the general population seem real but frequently inconclusive. Music is extremely complex with personal preference and various temporal elements as potential confounds; inconsistencies should "…be expected when properties of music vary across studies" (Kellaris & Kent, 1993). These studies were conducted with a variety of age groups with different music genres and tempi, but all studies were conducted with typical populations. Due to potential differences in physical and emotional reactions caused by inherent differences between a typical population and a population diagnosed with attention deficits, a discussion of these differences, as well as a brief history of Attention Deficit-Hyperactivity Disorder diagnosis developments is warranted.

Brief History of Attention Deficit-Hyperactivity Disorder

Attention Deficit-Hyperactivity Disorder (ADHD) is a clinical diagnosis with potentially negative consequences such as low self-esteem and social challenges (Altenmaeller, 2007). The diagnosis, despite being one of the most studied pediatric diagnoses, has become controversial as diagnoses and prescriptions rise for the disorder in the midst of public debate between ADHD as a "socially constructed disorder rather than a valid neurobiological disorder" (Connor, 2011, p. 1). Although this disorder has been recognized for more than 100 years, Attention Deficit

Disorder (ADD) was not named as such until the 1960s. ADD first appeared in the *Diagnostic and Statistical Manual of Mental Disorders, Third Edition* (DSM-III) published in 1980 and was distinguished with and without hyperactivity (ADHD) by the fourth edition (DSM-IV) published in 1994 (Bussing & Grohol, 2013). Prior to the 1960s, ADD was also known as "brain-injured child syndrome," "minimal brain damage," and "hyperkinetic impulse disorder" (Baird, Stevenson, & Williams, 2000). Although individuals with ADHD have no missing cognitive features, they are less effective in controlling and monitoring their mental process (Baird, et al., 2000). A person with ADHD may know and remember the behavioral expectations of a situation but may be unable to sustain the expected behavior or respond to a situation with the action considered most appropriate.

Symptomology and diagnosis. As described in the *DSM –V* (American Psychiatric Association, 2013), an individual can be diagnosed with ADHD as an inattentive type, a hyperactive-impulsive type, or a combination of the two. An individual with inattentive type exhibits six or more of the following symptoms for longer than six months if under the age of 17: lack of attention to details or careless mistakes, difficulty sustaining attention in tasks, does not seem to listen when spoken to directly, does not follow through on instructions or tasks, organizational difficulties, avoids tasks that require sustained mental effort, loses necessary items for tasks, easily distracted, or often forgetful. An individual diagnosed with hyperactive-impulsive type displays six or more of the following symptoms for six months or more if under the age of 17: often fidgety, leaves seat in situations requiring sitting, restlessness or running around in inappropriate situations, often has difficulty playing quietly, often in constant motion, often talks excessively, often blurts answers before question is completed, difficulty waiting for a turn, and often interrupts others' discussions or activities. For those over the age of 17, at least five symptoms of either type is required for diagnosis; the combination type meets the criteria of both types in either age group. These symptoms are pervasive enough for six months that they affect the individual's daily life and those around them in at least two or more settings, such as school and home. To be considered for an ADHD diagnosis, the symptoms would present before the age of twelve, are inconsistent with expected developmental level, and cannot be attributed to another disorder.

Diagnosis of ADHD should be made by a licensed professional. A comprehensive evaluation typically includes reports from the patient and others close to the patient, such as a parent or guardian (Children and Adults with Attention-Deficit/Hyperactivity Disorder [CHADD], 2014a). Diagnostic tools typically include checklists or rating scales to quantify behaviors, such as the Conners' Rating Scales, the Vanderbilt Assessment Scales, or the Barkley Home and School Situation Scales (CHADD, 2014b). These scales include items that assist trained clinicians determine patterns of hyperactivity, impulsivity, and/or inattention through statements and may be used to collect data from other sources including parents, teachers, and self-report forms. For example, the Conners' rating scale (Conners, Erhardt, & Sparrow, 1998a)—used in the current study and explained further in Chapter 3—directed participants to determine how much each statement related to their typical behavior on a zero to three scale. Sample statements included: "I am always on the go, as if driven by a motor" and "I have trouble keeping my attention focused when working."[2] The ratings are then divided into categories of behavior (i.e. hyperactive, impulsive, inattentive, problems with self-concept) and converted to T-scores based on normative group comparison, including DSM-IV criteria for each subtype and an overall index (Conners, Erhardt, & Sparrow, 1998a).

[2] The complete Conners' CAARS Rating Scales can be obtained from Multi-Health Systems, Inc.

It is estimated that 5.29% of children under the age of 18 have ADHD worldwide, with males diagnosed approximately twice as frequently as females (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). ADHD diagnoses have increased in the United States with 11% of children diagnosed in 2011—approximately 2 million more than diagnosed in 2003—of which over two-thirds have been prescribed ADHD related medication (Visser et al., 2014). Worldwide adult prevalence of ADHD is slightly lower with approximately 2.5% of people over age 18 diagnosed (Simon, Czobor, Bálint, Mészáros, & Bitter, 2009); however, the diagnostic prevalence is approximately 4.4% in the United States with a male to female ratio of 1.6 to 1 (Kessler et al., 2006). Approximately 60% of those diagnosed as children could continue their symptoms into adulthood (Bussing & Grohol, 2013).

Children diagnosed with ADHD experience difficulties in social situations—such as school—and may have other conditions that tend to associate, or be comorbid, with this diagnosis. Children with ADHD combined subtype are most likely to be comorbid with Oppositional Defiance Disorder (ODD) and Conduct Disorder (CD) as compared to a predominately hyperactive/impulsive or inattentive subtype; predominantly hyperactive/impulsive subtype comorbid with these disorders more than predominately inattentive type, which tend to be more withdrawn (Willcutt et al., 2012). Disorders considered to be external, such as ODD and CD, are more commonly found in males with ADHD. Internalization disorders, such as anxiety, separation anxiety, and major depressive disorder, are more common in females with ADHD (Baird, et al., 2000; Jensen, Martin, & Cantwell, 1997a; Willcutt et. al., 2012), with females more likely to be diagnosed as predominately inattentive (American Psychiatric Association, 2013). Learning disabilities can also be comorbid with ADHD (Baird, et al., 2000), with predominately inattentive type having a higher propensity for concurrent diagnosis (Willcutt et al., 2012). In addition to comorbidity, adolescents with ADHD have a higher rate of smoking and possibly alcohol and drug use (Whalen, Jamner, Delfino, & Lozano, 2002). Smoking is especially common as nicotine is a stimulant; stimulants such as Ritalin frequently have been used as an ADHD treatment (Richters et al., 1995). Although stimulants are commonly used as a treatment option for ADHD, they have not been demonstrated effective across the life span and, at times, have interacted with comorbid conditions, such as anxiety, among other concerns (Richters et al., 1995).

People with attention deficits tend to achieve at lower achievement levels than their peers (Frazier, Youngstrom, Glutting, & Watkins, 2007) while having a higher instance of substance abuse (Whalen et al., 2002). Individuals diagnosed with ADHD tend to have lower self-esteem than their peers because their behavior, though difficult to control at times, proves frustrating to themselves and others (Altenmaeller, 2007). Despite knowing the appropriate actions required for a given situation, individuals with attention deficits may not be able to act appropriately "in the moment," resulting in negative social consequences and possibly incarceration. For example, the overall prevalence of ADHD among adult prison inmates admitted into the Colorado Department of Corrections over a nine-month period was 10.5% as compared to the general adult population at a level between 2 – 5% (Cahill et al., 2012). These frequent negative encounters can result in a low self-image in social and academic schemas.

Possible causes of ADHD. A variety of causality theories exist as to ADHD's evolutionary and biological development. Although exact causality has not be determined for ADHD, strong evidence of genetic links exist (Baird, et al., 2000; Barkley, 2000; Jensen et al., 1997b; Shelley-Tremblay & Rosen, 1996). Shelley-Tremblay and Rosen (1996) reviewed three possible evolutionary reasons for ADHD's existence: the hunter, the fighter, and the wader. The hunter theory states that distractibility, impulsiveness, and aggression would have been advantageous in an environment before agriculture developed on a larger scale. Hunters would constantly monitor their environment and face danger. The fighter theory also shows the benefits of aggressiveness when based on the idea that our species fought our genetic predecessors for resources; impulsiveness, lack of inhibition, and reduced attention would be an advantage in warlike settings. The farmers of this environment would be those without ADHD. The wader theory points to behaviors “left over” from adaptations of a marine environment. Hypervocalization, for example, could have been an adaptation for survival. If a child were carried away by the tide, hand signals would not be adequate to gain the mother’s attention, thus the voice developed.

Jensen et. al. (1997b) point to the prevalence of ADHD in the population causing necessity for an evolutionary explanation. The researchers posit that inattention, hyperactivity, and impulsivity of ADHD would have been desired traits of natural selection in our ancestors’ potentially harsh environments. Individuals with these characteristics would be considered “response ready” as hunters in a hunter/gatherer culture or as warriors in more developed societies. As societies became more industrial and organized, hyperactivity was not as needed to identify potential dangers or new opportunities. Rapid scanning of the area was not as necessary in an environment with fewer threats; impulsivity, or quick decision-making, was also less needed. With increased organization, traits once used regularly in a more inhospitable setting became maladaptive.

From a biological perspective, individuals with ADHD develop some brain structures smaller than normal, including but not limited to the prefrontal cortex (Baird, et al., 2000). Barkley (2000) identifies the prefrontal cortex as controlling the executive functions, which include intentional actions, inhibition, resistance to distraction, problem solving, selection, monitoring, flexibility of actions in tasks, persistence in goal attainment, and self-awareness across time. He further suggests that ADHD impairs social intelligence through deficits in the executive functions and self-regulation. Although the exact percentage of adults who continue to display symptoms of ADHD from adolescence is unknown, these deficits are maintained into adulthood if the individual continues to be classified as having ADHD. Gains are made as the adolescent becomes an adult, but an individual's executive functions remain significantly lower than individuals without ADHD (Fischer, Barkley, Smallish, & Fletcher, 2005).

Another theoretical biological factor of ADHD involves dopamine production; produced in the brain, the hormone dopamine is associated with pleasure or rewards among other purposes (Menon & Levitin, 2005; see also Li, Sham, Owen, & He, 2006 for complete meta-analysis of relationship between dopamine and ADHD). Ritalin and other medications used to treat attention deficits control the levels of dopamine between the synapses, therefore keeping more dopamine in the system. "The medication [Ritalin] increases the child's ability to inhibit and regulate impulsive behavior by slowing down the dopamine transporters, so the child has time to consider options before responding" (Rickson, 2006, p. 41). Caffeine and nicotine, also stimulants, achieve a similar reaction in the brain as do enjoyable stimuli such as listening to music (Menon & Levitin, 2005; Whalen et al., 2002).

Studies Involving Music with ADHD Participants

Two studies, Wiebe (2007) and Pratt, Abel, Skidmore (1995), involved the examination of music's effect on ADHD participants. Wiebe (2007) conducted a case study with a 14-year-old boy who found he was better able to focus and retain material when studying with background music. Although not generalizable due to small sample and the qualitative nature of the study, Wiebe's work supported music's positive effects on mood, attitude, and motivation in an adolescent male with ADHD. Pratt, Abel, Skidmore (1995) used electroencephalograph (EEG) neurofeedback training to help children with ADHD control their brain wave patterns; background music was played for the experimental group during the training. The researchers found that three participants in the music group were altering their brain wave patterns to the rhythm of the music. Participants in the experimental group displayed greater improvement in focus behaviors than the control group completing the task in silence. The researchers called for similar studies using larger samples with "focus exclusively on one variant of attention deficit disorder" (p. 31).

Much research is needed in a variety of controlled conditions to ascertain music's impact on each indicator of attention deficit disorder. By focusing on one indicator, the researcher may more accurately advise students regarding their music use based on the kind of attention deficits that may be present. Although several researchers have studied the effects of music in this population, none have focused on one specific indicator of attention deficits to date. No researcher has investigated the effect of background music on college students with attention deficits.

Problem Statement and Overview of Method

The purpose of this study was to investigate the effect of music listening on impulsivity as judged by the Conners' Continuous Performance Test (CPT) II v. 5. College undergraduate students were administered a computer task to complete in both a silence and a music condition; one group of participants had no diagnosed history of ADHD while the other had a history of ADHD. Because no similar studies have been conducted, it was uncertain if music playing during the task would have a significant effect on either group of students. The lack of extant literature contributed to the design, in that the effects of music on impulsivity is unknown in both the general population as well in individuals with attention deficits.

Based on the unique characteristics of those with ADHD, reactions and physiological indicators of those with ADHD may differ from the typical population in the presence of music stimuli. The following chapter will discuss literature specifically relating to possible theoretical effects based on ADHD characteristics as described in DSM-V (American Psychiatric Association, 2013) and research exploring background music use with participants having ADHD. Chapter 3 will describe the methodology and study design, with results presented in Chapter 4. The discussion in Chapter 5 will include a summary of findings and links to existing literature, recommendations for future research, and limitations of the current study.

CHAPTER 2: BACKGROUND MUSIC USE IN SPECIALIZED POPULATIONS

Due to limited extant literature, it is difficult to know all potential factors of background music use and use of music with those diagnosed with ADHD. Some phenomenon specific to music or to ADHD, however, would be important to consider. Music specific factors include the human ability to entrain (described in the following section) and the use of music in mood regulation, while factors specific to ADHD include the participant age and the participants' diagnosed subtype. One factor encompassing both music and ADHD is the role of arousal and stimulation in human perception and how these differ between those with and without ADHD. These considerations have been outlined in the beginning of this chapter, which is followed by a literature review of studies utilizing background music with specialized populations.

Entrainment

Savan (1999) suggested a potential reason for "angry, disruptive, aggressive behavior often exhibited by pupils with special needs may result from frustration due to a lack of coordination" leading to the "inability to perform manual tasks effectively and efficiently" (p. 143). A phenomenon that may aide people with these coordination difficulties is known as entrainment. Entrainment can be defined as spatiotemporal coordination—coordination of pulse in both space and time— or "coordinated rhythmic movement" with a variety of social and/or auditory signals (Phillips-Silver, Aktipis, & Bryant, 2010, p. 4). Many organisms can show signs of entrainment through matching of biorhythms to environmental factors; for example, organisms typically can be classified as diurnal—awake during the day—or nocturnal due to wakefulness at night because their sleep cycles matched the rising and setting of the sun (Bispham, 2006; Hodges, 2009; Phillips-Silver, et al., 2010). Human entrainment can occur under different and more complex conditions than other organisms.

The three distinguishing features of human entrainment include complexity, tempo, and crossmodality. Unlike other organisms, human entrainment typically occurs in more complex contexts than a steady isochronous pulse—a circumstance in which each pulse occurs at equal intervals from other pulses, such as a metronome (Phillips-Silver, et al., 2010). Humans can entrain to a wide range of tempi, which also distinguishes human entrainment from other organisms. Finally, human entrainment is crossmodal in nature meaning that signals are integrated using a variety of senses. Although synchronization is the goal of entrainment, sound production is not a requirement (Phillips-Silver, et al., 2010); rather, there exists an interplay between rhythmic detection and a rhythmic action or response. For example, ballroom dancing typically requires that two people entrain with the music—the beat of the music in whatever tempo is presented—while coordinating actions with each other. Ballroom dancers may clap or stomp, which does produce sound, but most of their movements do not have the goal of producing a sound with the music. The pair would also demonstrate crossmodality, as ballroom dance requires full body movements in response to the music's pulse, tempo, and style while reacting to the movements of the other person.

Three components are necessary for entrainment to occur: rhythmic detection, rhythmic action, and integration of the two. Detection involves the auditory system while action engages the musculoskeletal system. The integration of detection and action occurs in the brain; adjustments are made to the rhythmic action based on what is heard during rhythmic detection. These adjustments are necessary for entrainment to ensue (Phillips-Silver, et al., 2010), which reinforces entrainment's crossmodal property as detection through the senses is integrated for a resultant rhythmic action to occur.

Use of entrainment as a therapy is not a new concept. Entrainment has been used to help people regain speech function and gait (Hodges, 1996). Some researchers have found correlational entrainment between music tempo and blood pressure and respiration rate (Ellis & Thayer, 2010). The KidsEnabled.org website promotes entrainment as a way to increase focus and cognitive skills; although people develop their rhythm skills through games and childhood rhymes, a variety of programs are suggested for those requiring more intervention with these skills (Ardell, 2010). One program, Interactivemetronome.com, promotes entrainment as a way to increase focus and cognitive skills; Interactive Metronome uses a computer and requires motor responses from the participant in time with the pulse. This program has been used to improve golf swings, general motor coordination, speech and language, and reading achievement by coordinating these activities using a steady pulse (Interactive Metronome.com, 2014). For those experiencing lack of coordination or difficulty or task completion efficiency, entrainment with background music could be a viable technique to aide in task completion.

Mood Regulation

Due to the behavioral and neurological differences between those with and without ADHD, the effects of background music use may be enhanced. A potential benefit of background music for those with ADHD could be elevated mood. Saarikallio and Erkkila (2007) found that adolescents use music as a way to regulate mood states, with changing mood including expression, intensification, or comfort dependent on previous mood state. People diagnosed with ADHD tend to report negative moods (Whalen, et al., 2002). Comorbidity with other conditions—such as depression and anxiety—can be a factor in negative mood, as these diagnoses are frequently associated with an ADHD diagnosis.

Dopamine levels could contribute to mood, as the hormone dopamine is linked with pleasure and reward (Menon & Levitin, 2005); stimulants are frequently used to keep dopamine in the system longer, which gives a person with ADHD more time to respond (Menon & Levitin, 2005; Rickson, 2006). Because stimulants affect dopamine levels and tend to improve behavioral indicators of those with attention deficits, dopamine levels have been connected with the ADHD diagnosis (see Li, Sham, Owen, & He, 2006 for complete meta-analysis of relationship between dopamine and ADHD). However, listening to music also causes dopamine release, which could benefit those with ADHD (Menon & Levitin, 2005). It is possible that a person with ADHD could reasonably be assisted by listening to background music due to music's effect on mood (Lesiuk, 2010; Schellenberg, Nakata, Hunter, and Tamoto, 2007), anxiety (Lai et al., 2008; Stanton, 1973), arousal due to stress (Pelletier, 2004), and in addition to dopamine release (Menon & Levitin, 2005). Those with ADHD frequently claim the benefits of music anecdotally, but few researchers have attempted to quantify the potential benefits music may provide.

Participant Age

Participant age is another factor that may affect reaction associated to background music use. College students with ADHD could be considered a subgroup of those with attention deficits due to high functioning in comparison to peers with ADHD (Frazier et al., 2007; Heiligenstein & Keeling, 1995; Lewandowski, Gathje, Lovett, & Gordon, 2013). Prevalence rate is estimated to be 2% to 8% of college students having ADHD, with approximately 25% receiving disability services through their respective campuses (DuPaul, Weyandt, O'Dell, & Varejao, 2009); however, these estimates are only preliminary due to the lack of literature specific to this population (DuPaul et. al, 2009; Frazier et al., 2007) and the lack of required disclosure for such diagnoses upon entering college (Weyandt & DuPaul, 2008). Although university students with

ADHD still struggle in academic pursuits, in comparison to peers, due to underdeveloped organizational, planning, and study skills (DuPaul et al., 2009; Frazier et al, 2007; Heiligenstein & Keeling, 1995; Norwalk, Norvilitis, & MacLean, 2009; Weyandt & DuPaul, 2008), "college students with ADHD are likely to have (a) higher ability levels, (b) greater academic success during primary and secondary school, and (c) better compensatory skills than individuals with ADHD from the general population" (Frazier et al., 2007, p. 54).

It is possible that college students with attention deficits have found solutions or coping mechanisms for their deficiencies, which helped them persevere through high school and into college (Frazier et al., 2007; Heiligenstein & Keeling, 1995). Despite overcoming difficulties, college students with ADHD can find organizational demands particularly challenging if their previous compensations included parent or guardian supports—typically limited or nonexistent when these students begin college (Heiligenstein & Keeling, 1995)—or a structured high school environment (Norwalk, Norvilitis, & MacLean, 2009). College students continue to be at risk for social adjustment possibly due to low self-esteem and/or lack of familial structure (Weyandt & DuPaul, 2008). Lack of self-esteem or self-efficacy has been evidenced by Lewandowski et. al. (2013) who found self-perception the only significant difference between groups of college students from the typical population and the ADHD population. The researchers found no significant differences in four reading tasks or test-taking behavior and did not provide any accommodations for the tests; however, the students with ADHD had more anxiety regarding taking a timed test and "perceived themselves as being slower readers and inferior test takers" despite similar performance in comparison to their typical peers (p. 49). Predicting background music's effect on college students with ADHD is challenging as coping mechanisms and high-ability levels may cause students in this age group to react to music stimuli similar to their typical peers compared to others diagnosed with ADHD.

Participant Subtype

ADHD can be diagnosed as one of three subtypes: predominately hyperactive-impulsive, predominately inattentive, or a combination of the two (American Psychiatric Association, 2013). All diagnoses of ADHD have been associated with academic difficulty, but “inattention symptoms [as opposed to] the hyperactive symptoms, were predictive of lower CDMSE [Career Decision-Making Self-Efficacy], study skills, and academic adjustment" (Norwalk, Norvilitis, & MacLean, 2009, p. 256). Further, inattentive symptoms were found an important predictor of academic performance; those with high self-reported inattention scores—scores exceeding two standard deviations above the mean—had a 34% higher chance of academic probation than a student not reporting inattention (Frazier et al., 2007). The correlation between inattention and academic achievement may be more of a concern for college students due to decreased hyperactivity symptoms during adolescence; these symptoms become more internal and “may be confined to fidgetiness or an inner feeling of jitteriness, restlessness, or impatience” (American Psychiatric Association, 2013, “Development and Course”). Because the subtypes are diagnostically different, the response to background music could also vary for each subtype.

The Role of Arousal and Stimulation

“Given that music can directly impact arousal, with optimal levels of arousal increasing performance on certain cognitive tasks” (Robb, 2003, p. 278), arousal and stimulation theories quickly emerge as a potential confound. Three theories are summarized briefly below: the Yerkes-Dodson Law of Arousal, the Optimal Stimulation Theory, and the Moderate Brain

Arousal model. Although other theories may be applicable, these theories were chosen due to mention in the literature on which this document is focused.

The Yerkes-Dodson Law of Arousal was discussed as part of a study using mice as subjects. Yerkes and Dodson (1908) noted the mice were slower in habit formation during conditions of weak and strong stimuli; however, habit formation was accelerated or maximized in a condition with moderate stimuli (p. 481). Although Yerkes and Dodson (1908) used mice in this study, this law has been generalized to the human population. Individual arousal levels change frequently in humans throughout a typical day with higher arousal exhibited during sudden or surprising situations and lower arousal during more calm or monotonous conditions (Mehrabian, 1977). Therefore, the Yerkes-Dodson Law of Arousal alone may not be sufficient to describe the potential arousal patterns of those with ADHD. Ornitz et al. (1997) found that boys with ADHD reacted to negative stimuli differently than their typical male peers. The ADHD group had an excessive pleasurable reaction to negative stimuli—loud, startling noises— in comparison to boys without ADHD while watching a silent movie. Heart rates were also measured in this study to show the participants' arousal levels; those with ADHD did not show a "sustained increase" in arousal as judged by heart rate, which was not the true of their typical peers who showed an increase in arousal throughout the experiment (p. 1704). Hence, the potential for different responses to a variety of stimuli is a consideration for those researching ADHD.

In the Optimal Stimulation Theory, Zentall and Zentall (1983) "defined activity as a regulatory mechanism for the maintenance of optimal sensory input" (p. 450). Similar to Yerkes-Dodson, behaviors are linked to the amount of arousal; however, this theory also includes the control or manipulation of arousal through activity. Activities linked with distractibility and the quest for stimulation can include "increased locomotor activity, looking around, and increased verbalization" (Zentall & Zentall, 1983, p. 453). Abikoff, Courtney, Szeibel, & Koplewicz (1996) posit that distractibility of children with ADHD may be a way to compensate for underarousal as they search for "stimulation or novelty" through various activities such as looking around or excessive movement (p. 238-9). Background music could be another source of stimulation that may help to decrease distractibility in those diagnosed with ADHD.

Sikstrom & Soderlund (2007) proposed one additional model encompassing both arousal and dopamine release: the Moderate Brain Arousal (MBA) model. This model has been built around the phenomenon of stochastic resonance, in which a stimulus that would typically be undetected by an observer becomes detectable or noticeable when another stimulus—noise—is added (p. 1053). Moderate noise levels allow for the best detection of a previously undetected stimulus, while strong or weak noise levels caused detection abilities to decline; this is similar to the Yerkes-Dodson Law of Arousal in that moderate stimuli were found to optimize habit formation in comparison to weak or strong stimuli. However, "…the peak of the [stochastic resonance] curve depends on the dopamine level, so that participants with low dopamine levels (ADHD) require more noise for optimal cognitive performance compared to controls" (Söderlund, Sikström, & Smart, 2007, p. 844). Adding sound to the background is one way to add novelty to a situation, but it may also increase cognitive functioning by raising dopamine levels in those diagnosed with ADHD.

Few studies have been completed to assess the effects of background noise or sound on people diagnosed with ADHD. Söderlund, Sikström, & Smart (2007) compared white noise to silence as a background for the following cognitive tasks: a "high memory performance task, and a verbal task (VT), as a low memory task" (p. 840). In comparison with a silent condition, participants with ADHD performed better on the cognitive tasks in the white noise condition; however, their typical peers performed better in silence. The addition of background music has also been found beneficial to those diagnosed with ADHD by several researchers during activities such as manipulating brain wave patterns (Pratt, Able, Skidmore, 1995), motor tasks (Klien, 1981), completing math problems (Abikoff et al., 1996; Scott, 1970), completing homework and studying (Wiebe, 2007), and free play (Cripe, 1986). Abikoff et al. (1996) noted "level of appeal, rather than the mere presence of stimulation, appears to be the critical influential feature for children with ADHD" (p. 243).

The previously identified factors of entrainment, mood regulation, participant age, participant subtype, and arousal/stimulation theories could confound study results. Many of these factors either have been understudied or may look different in a population having attention deficits. Evidence is limited as to which factors may account for the most variance in a proposed model due to the small extant literature base. The literature reviewed in the following sections show the potential benefits to those with special needs while listening to background music.

Background Music Use with Specialized Populations

Although the populations included in this section were not identified as having ADHD, similar behavior issues were recognized as those associated with ADHD symptomology. Also, studies included in this section did not exclusively target specific diagnoses, but rather referred to participants as having "emotional and behavior disorders." Due to the small body of extant literature and similar behavior issues, the studies below were included to further show the benefits found in background music use in students with Intellectual Disabilities (formally known as Mental Retardation or MR) and emotional and behavioral disabilities.

Gregoire (1984) used a Paraguayan harp ballad in triple meter during a short rest period to enhance concentration of participants with Intellectual Disabilities (ID) as compared with a silent rest period. The rest period was immediately followed by a number matching task. The participants were divided into two groups—a younger group and an older group—in a repeated measure design. In five of the six comparisons, no significant differences were observed in the matching task; however, in the sixth comparison, a significant increase was found during the silent condition. It was also noted that the older group had a decrease in negative behaviors during a rest period when music was played in the background.

Reardon and Bell (1970) found that "stimulative" music decreased self-stimulation behaviors in boys with severe ID. Participants were placed in four sound conditions—a silent control, stimulative music, sedative music, and spoken recording—over a period of four days for each sound condition; the sound stimuli lasted one hour during each evening of the study. Due to the consistent resurgence of self-stimulation behaviors on Day 3 of each sound condition, it was inconclusive whether the music or the novelty of the sound caused the decrease in self-stimulation behavior.

Savan (1998) found when students with behavioral issues listened to the works of Mozart it positively affected their behavior during 70-minute science lessons, which resulted in students being "calm," "efficient," and "cooperative" as opposed to talking or arguing with one another, requesting excessive bathroom breaks, or other off-task behaviors (p. 33). A significant difference was found in physiological indicators between a science lesson during a condition—playing music by Mozart—as compared to a condition with no music. Participants' blood pressure, pulse rate, and body temperature showed significant decreases when listening to background music by Mozart.

In a subsequent study, Savan (1999) found students with emotional and behavior disorders showed an increase in coordination and positive behaviors while exhibiting a significant decrease in blood pressure, body temperature, and pulse while listening to recorded works of Mozart during class. Although seven versions of Mozart orchestral excerpts were utilized, the first four tapes lacked manipulation of pitch or frequency. Tape 1was an unaltered performance of the excerpts while tape 2 and tape 3 were manipulated to be one-third faster and one-third slower than the original recordings, respectively. Tape 4 was the symphony recording played in reverse. Significant differences were found in physiological indicators with those four tapes; no significant differences were found with filtering sound above 700 Hz, below 700 Hz, or transposition of the performances up two octaves. The reduction of the physiological parameters was linked to more positive behaviors in the classroom such as increased concentration, fewer attention-seeking behaviors, lower noise level, and task completion.

Hallam and Price (1998) tested the effect of calming music on ten students with emotional and behavioral difficulties. A significant increase in math problem accuracy was found among the four music sessions and the four non-music sessions. Although no significant difference existed in the number of rules broken throughout the eight sessions, the researchers reported that “the pupils who benefited most were those whose difficulties were associated with constant stimulus seeking and over-activity, closely resembling the ‘hyperactive’ syndrome” (p. 90).

The literature described in this section included a variety of ages and populations. Although some of the participants may have similar behavioral patterns as those diagnosed with ADHD, only Hallam and Price (1998) specifically mentioned participants who may have suffered from “Hyperactive syndrome”—a prior term used to describe individuals with ADHD.

Researchers focusing on background music use and participants diagnosed with ADHD have been summarized in the next section.

Background Music Use and Attention Deficits

Background music has been used both as a therapeutic tool alone or in combination with other therapies with those diagnosed with attention deficits. One such therapy is electroencephalograph (EEG) neurofeedback training, which has shown success as an alternative therapy for those diagnosed with ADHD in improving focus, concentration, impulse control, mood control, relaxation, and on-task behavior with a self-regulation emphasis. Pratt, Abel, and Skidmore (1995) used EEG neurofeedback training with nineteen subjects ages 6 to 17 classified as ADD or ADHD. Thirty-nine sessions were conducted at a rate of three sessions per week. Sessions involved a computer game that participants used to change their brainwave patterns. In addition to traditional training, an experimental group listened to the music of Mozart during their sessions. Mozart was used because of its patterned rhythm. Although all subjects reported post-treatment improvement—with 70% maintaining improvement six months after session completion—significant improvement only existed in participants with ADD who listened to Mozart. It was noted that three participants may have been entraining, or coordinating their movements, to the music "during the theta bar reduction task" (p. 31) in rhythm to the music. No significant differences were found between the control and experimental groups. Pratt, Abel, and Skidmore (1995) called for similar studies using larger samples with "focus exclusively on one variant of attention deficit disorder" (p. 31).

In a study by Klien (1981), background music was found to benefit students with attention deficits. Klien found that slower tempo music allowed 65% of hyperactive participants to have results closer to that of the typical population on a motor task measuring speed and accuracy. All 80 participants, 40 with hyperactivity and 40 typical students, were most inaccurate with the fast tempo music. Exact tempi were not specified; however, *The Blue Danube*, Op. 314, and *The Emperor's Waltz*, Op. 437 were slowed to two-thirds normal tempo for the slow music sample and increased to 1.5 times normal tempo for the fast sample (p. 160).

In addition to Western Art music, rock music has also been shown to assist students with attention deficits. Abikoff, Courtney, Szeibel, and Koplewicz (1996) recruited 20 boys with ADHD and 20 typical boys to complete an arithmetic task under three sound conditions: background music, background speech (an audiotape of the business report recorded from the local television broadcast), and silence. Music was selected based on each participant's individual preferences with 98% choosing rock or rap music, and math problems were selected based on each participant's individual ability level as judged by screening tests given on day one. Participants without attention deficits scored higher on both the vocabulary and the math screening tests. Each participant with ADHD was matched with a participant of the same grade level without ADHD; pairs were tested simultaneously and administered a math test at one grade level lower than judged by the math screening test. Participants were administered the math tests in 30-minute sessions, experiencing a different sound condition every 10 minutes. Sound conditions were rotated throughout the groups. Students with ADHD receiving the music condition first had significantly more correct answers than those who received music as a later condition. The music-first group also had significantly more correct answers than all other participants, including the "nondisabled" children (p. 242).

In a case study by Wiebe (2007), rock music was found to help an adolescent with ADHD concentrate on homework, increase comprehension, and display a more positive mood when listening to his favorite music. The study was conducted over a 14-week period and included detailed information from both the participant and his parents. Teachers were also interviewed. The participant frequently used music to regulate his mood, which in turn helped him persist in his schoolwork.

Scott (1970) used music from the Beatles as a background to examine math performance among four students with hyperactivity. Participants were asked to solve math problems under "normal" classroom conditions (open and separate desks) without background music, "normal" classroom conditions with background music, booth condition (each participant in an individual study carrel), and booth condition with background music. Three of four participants showed a significant increase in math problems completed and problems answered correctly in the "normal" classroom condition with background music; all four participants showed an increase in math problem completion in both music conditions as compared to the conditions without background music.

Cripe (1986) also used rock-and-roll music to assess activity levels among eight boys, ages 6 through 8, with attention deficits. Each participant was tested individually in a playroom. One half of the observation time involved play without music; for the remainder of the time, the participants continued to play while listening to music through a set of headphones. These individuals showed a significant decrease in activity level while listening to music as compared to the no music condition. Observers recorded more instances of activity when the music was not present.

Previous researchers have shown potential benefits of using background music to enhance various activities, specifically those diagnosed with attention deficits; however, no studies have been completed using background music with college students having ADHD. In addition, none of the authors chose a specific characteristic of ADHD to test systematically the effect of background music on participant behavior. The purpose of this study was to investigate the effect of music listening on impulsivity as judged by the Conners' Continuous Performance Task (CPT) II v. 5.

Research Question

Will there be a significant difference in the level of impulsivity among participants as judged by the Conners' Continuous Performance Task (CPT) between an initial condition, a music condition, and a silence condition?

$H_0$1: There will be no difference in impulsivity by group as assessed by the CPT among any of the three conditions**.**

$H_0$2: There will be no difference in impulsivity by condition as assessed by the CPT among any of the three conditions**.**

$H_0$3: There will be no interaction effect between the factors of group and sound condition.

Definition of Terms

1. Attention deficits: This term denotes any form of attention deficits diagnosed using the current version of the *Diagnostic and Statistical Manual of Mental Disorders (DSM IV-TR)* including hyperactivity with or without impulsivity, inattention, and any potential combinations of these three diagnoses without consideration of comorbidity.
2. Comorbidity: Conditions that tend to associate with the primary diagnosis.
3. Impulsivity: A chronic inability to delay a response to a stimulus.
4. Entrainment: Spatiotemporal coordination (Phillips-Silver, Aktipis, & Bryant, 2010); the human ability to coordinate movement with a beat.

5. Mozart Effect: The generalization connecting increased intelligence to listening of music by Mozart.
6. Conners' Adult ADHD Rating Scales (CAARS): A 66 item survey that addresses symptomology as found in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* of ADHD including "inattention/memory problems, hyperactivity/restlessness, impulsivity/emotional lability, and problems with self-concept" (Conners, Erhardt, & Sparrow, 2012a). The form used for this study will only be self-report and will be used to obtain a profile for each participant, but an observer form can also be used to provide further information when used as a diagnostic tool.
7. Conners' Continuous Performance Task (CPT) II v. 5: A computerized assessment used to measure attention deficit symptoms and neurological functioning. The participant taps the spacebar every time a letter flashes on the screen except for the letter "X." The program measures indicators such as reaction time, tapping the spacebar on the "X," and vigilance and compares the participant's results to norm groups.
8. Lability: Likely to change

CHAPTER 3: METHODOLOGY

The purpose of this study was to investigate the effect of music listening on impulsivity as judged by the Conners' Continuous Performance Test (CPT) II v. 5. College undergraduate students were administered a computer task to complete in both a silence and a music condition; one group of participants had no diagnosed history of ADHD while another group of participants had a history of ADHD. In this chapter, the methodology and study design are presented.

Participants

Participants for this study were recruited from a large university in the Southwestern United States. All participants were college undergraduate students between the ages of 18 and 24 both with and without attention deficits. The target recruitment, as determined by a power analysis, was 30 students with typical needs (i.e. students that did not require accommodations for mental and/or emotional disability) and 30 students with attention deficits. Using GPower 3.1.5 Freeware (1992-2012), the researcher was able to ascertain required sample size *a priori* using design and intended analysis, effect size $f = .25$, and power = .80. Based on GPower calculations, it was determined that a total sample of 28 participants—14 in each group—was required for the given specifications. However, it was determined to use 30 in each group due to the Central Limit Theorem— a sample greater than 30 would not equate to improvement in how well a sample represented a given population (Gravetter & Wallnau, 2013, p. 209).

Students self-identified as having attention deficits were to have a history of attention deficits either with or without medication; if a participant was told by a medical professional or an educator that testing for attention deficits was recommended, this qualified as having a history of attention deficits regardless of actual treatment history.

Advertisements for participant recruitment were made on Craigslist, Facebook, and the University Master Calendar. Flyers were posted in residence halls, buildings particularly known to assist students with learning difficulties, and other buildings that permit the posting of flyers for research recruitment on campus. Participants were informed they would be paid $10 cash for participation in the study. Per Institutional Review Board (IRB) protocols (Appendix A), written permission of some form was obtained before posting, which was primarily in the form of email communication.

Interested participants contacted the researcher via email, and the researcher emailed a consent form upon initial contact to allow for informed consent. Potential participants were asked to provide the following information: age, gender, confirmation of attention deficits, and several options for appointment times. These individuals were asked to email the researcher with the requested information after reading an attached consent form (Appendix B) as confirmation of intent to participate. Per IRB protocols, no students under the age of 18 were recruited regardless of when they would turn 18; they were invited to email the researcher again after their eighteenth birthday if participants were still being sought.

Recruitment was extended two times, which resulted in full enrollment of the typical needs group (n = 30, females = 18, males = 12, mean age = 20.47). However, the researcher modified both the recruitment flyer and protocol after the third recruitment was unsuccessful in recruiting students with attention deficits with only two volunteers recruited in the attention deficit group by the end of the second extension. Wording on the flyer was simplified based on recommendations from a colleague who worked with the target population on campus, and a reminder email was sent to potential participants approximately 48 hours after the initial recruitment information was sent. All modifications were approved by IRB before implementation. Recruitment was attempted over the summer months with little success; however, fall recruitment was successful, and the group with attention deficits was recruited between the beginning of the fall semester and midterm (*n* = 29, females = 16, males = 13, mean age = 20.41; *N* = 59).

Due to attrition and technological difficulties, the total sample size decreased during the course of the study. The final sample was *N* = 51 with *n = 26* enrolled in the typical group and *n* = 25 enrolled in the group with attention deficits. Two participants in the attention deficit group became unavailable for testing and withdrew from the study; two additional participants did not meet the criteria for analysis due to self-observed rather than corroborating history of attention deficits, which reduced the number in the group to n = 25. In the typical group, one participant became unavailable for testing and withdrew from the study. Two additional participants in the typical group were removed from analysis due to technical issues in the music condition; in both testing sessions, the CD player malfunctioned during the CPT. One participant was removed from the typical group due to extreme scores across all measures in the testing session in comparison with the typical group, which reduced the number in the group to n = 26.

A breakdown of collected intake information can be found in Table 1. Table 2 contains subtype information as reported by participants in the ADHD group with self-reported comorbidity shown in Table 3 for both groups. Although the typical group was not required to report other conditions, five participants did report diagnoses for anxiety or depression. Mean T-scores and Standard Deviations for attention deficit behavior categories collected using the Conners' Adult ADHD Rating Scales (CAARS) can be found in Table 4. These scores were collected to show the general differences in ADHD behavior indicators between the groups. All mean scores were consistently higher in the ADHD group as compared to the typical needs group with a mean difference ranging between 8.31 and 19.17 except for Self-Concept scores (mean difference = 3.42).

Table 1

Intake Information by Group

Group ***N* = 51**	**Gender**	**Mean Age**	**Year in College**	**Formally diagnosed with ADHD**	**Currently taking medication for ADHD**
Typical ***n* = 26**	Male = 10 Female = 16	20.58	Freshman = 6 Sophomore = 6 Junior = 6 Senior = 6 Fifth year = 2	Yes = 0 No = 26	Yes = 0 N/A = 26
ADHD ***n* = 25**	Male = 12 Female = 13	20.56	Freshman = 6 Sophomore = 3 Junior = 5 Senior = 6 Fifth year = 5	Yes = 19 No = 6	Yes = 11 No = 14

Table 2

ADHD Group and Self-Reported Subtype

Subtype	Frequency
Question left blank	6
Inattention	7
Hyperactivity	4
Impulsivity	1
Unsure	3
Inattention and Hyperactivity	1
Inattention and Impulsivity	2
All 3 Subtypes	1

Table 3

Self-Reported Comorbid Conditions

	Frequency by Group	
Comorbid Condition	**Typical**	**ADHD**
Blank/None of These	21	14
Anxiety	2	3
Depression	3	1
Learning Disability	0	3
Anxiety and Depression	0	3
Anxiety, Depression, and Learning Disability	0	1

Table 4

Mean T-scores and Standard Deviations of CAARS Categories by Group

	Inattention/Memory Problems		Hyperactivity/ Restlessness		Impulsivity/ Emotional Lability		Problems with Self-Concept	
Group	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Typical	50.19	6.63	50.73	8.10	45.00	7.98	52.50	8.31
ADHD	63.56	11.62	59.04	11.42	54.88	11.02	55.92	13.66

	DSM-IV Inattentive Symptoms		DSM-IV Hyperactive-Impulsive Symptoms		DSM-IV ADHD Symptoms Total		ADHD Index	
Group	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Typical	54.38	10.15	50.27	9.13	53.50	10.09	49.62	7.34
ADHD	73.56	13.41	62.68	10.61	71.80	12.01	61.40	10.96

Procedure

All protocols were established in cooperation with a psychiatrist at the University Medical Center, Dr. Jaswinder Ghuman, a specialist in the area of attention deficits. The testing protocols were peer reviewed by at least one of Dr. Ghuman's colleagues and pilot tested for this study. Protocols for this study were approved on February 18, 2013 by the Institutional Review Board at the University of Arizona, IRB Project 13-0112.

Due to recruitment challenges, the group with typical needs was tested at the end of the spring semester in which they were recruited to avoid attrition. Individual appointments were made with each participant after group recruitment was completed. All participants were randomly assigned a sound condition order by the researcher using stratified random sampling; the assignments were stratified to allow equal numbers of students with and without attention deficits in each condition order. Participants in the attention deficit group were assigned and stratified utilizing the same protocols. However, if a participant used attention deficit-related medication, the participant was asked to skip the medication on the appointment day.

At each appointment, participants were given an intake survey, reminded of their rights as study participants, and invited to ask any questions about the test or the study; participants were asked if questions regarding the study existed prior to each test administration. Participants were administered the Conners' Continuous Performance Test (CPT) a total of three times. The initial administration was used as a control condition with both the participant and the researcher in the room. The initial administration also served as a control for the confounding effect of practice as the participant became familiar with the CPT before administration in the music and the silence conditions.

After survey completion and initial CPT administration, the remaining conditions were administered in a separate space from the control administration. One CPT was administered in silence and the other with music playing in the background. Stratified random sampling was used to determine the first sound condition for each participant to avoid confounding factors of fatigue and order effect. The researcher established the condition and the CPT and then left the testing area. Participants were told to ask for help if technical issues occurred. Before the final test administration, each participant was given a short break outside of the formal testing area to avoid the confounding factor of fatigue, and per the suggestion of Dr. Ghuman, each participant was provided a small snack due to the large amount of energy required to focus on two 14-minute tests. The snack and break gave the participants the opportunity to “recharge” slightly before the third test administration. During this snack time, the CAARS assessment was administered. The final CPT was then administered in the same area as the previous test in the other condition. Below is the protocol in minutes for each participant.

5 minutes	Introduction, verification of paperwork, brief survey
14 minutes	Participant took initial Conners’ CPT on a laptop • Informal setting, such as researcher’s office • Researcher present
5 minutes	Moved to formal setting; condition set up (silence or music condition) • For music condition, music was played from sound system separate from the computer. Researcher selected a piece of music that had a tempo around 120 and “looped” the music to ensure it played for the duration of the test. • Same laptop computer used • Room door was left ajar so researcher can observe; subject was instructed to notify researcher if technical issues arose
14 minutes	Participant repeated Conners’ CPT in silence or music condition
15 minutes	Snack; Administration of the Conners’ CAARS survey; received compensation of $10 cash and signed sheet stating compensation received
14 minutes	Participant repeated Conners’ CPT in other sound condition (if silence first, than music or vice versa)

Total time: 67 minutes

Instruments

An intake survey was designed to ensure compliance to protocols, such as medication use, and to obtain other general information such as gender, age, and type of attention deficit present where applicable (see Appendix C). The survey was created with the help of an administrator whose office aids students with attention deficits and Dr. Jaswinder Ghuman, a psychiatrist at the University Medical Center. The remaining assessments were discussed with another psychologist recommended by Dr. Ghuman. Use of a signal detection program, used in testing assessment, was also recommended by the psychologist. The Conners' signal detection program, described below, was chosen after researching various signal detection programs based on cost considerations and unlimited usage; other programs were pay per test or sets of tests. The Conners' Adult ADHD Rating Scales (CAARS) (Conners, Erhardt, & Sparrow, 1998) were used to collect self-reported indicators of ADHD due to the researcher's familiarity with the assessment and the recommended psychologist's use as a screening tool.

Conners' Continuous Performance Test (CPT) II (Version 5) for Windows was used to measure impulsivity levels of the participants. The CPT, a signal detection program, used letter stimuli displayed at intervals of one, two, and four seconds. Participants were to press the spacebar on all letters except for X. If an X appeared on the screen, the participant was told to avoid pressing the spacebar. One complete CPT administration was 14 minutes in duration. Each participant's performance was compared to the test's normative group and converted to T-scores as part of the CPT program; the performance reports were downloaded and transferred to an Excel spreadsheet upon completion of the study.

The CPT II test Split-half Reliability was adequate with a majority of reliability coefficients ranging from .83 to .95. Exceptions included Beta (.73) and Variability (.66) (Conners & MHS Staff, 2004, p. 56). Based on the reported CPT Standard Error of Measurement values, it was determined that scores from the instrument were a reasonable match to true individual performance with 68% of the scores within one standard unit of the original score and 95% of the scores within 1.96 standard units for both Standard Error of Measurement and Standard Error of Prediction (Conners & MHS Staff, 2004, pp. 59-62). CPT II scores have been found to differentiate between the typical population and those with ADHD based on data from multiple sites (Conners & MHS Staff, 2004, p. 65), which gave the test statistical validation.

CAARS (Conners et al., 1998) self- report instrument long version was used to obtain a general profile of all participants and to allow for group comparison based on typical behavioral categories of ADHD. The CAARS Long Self-Report form contains 66 items and addresses symptomology as found in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* and "factor-derived subscales" including "inattention/memory problems, hyperactivity/restlessness, impulsivity/emotional lability, and problems with self-concept" (Conners, Erhardt, and Sparrow, 2012, "Product Overview"). Responses were categorized using the provided scoring grid and converted to T-scores based on norm group comparison. Because the CAARS was used for a profile rather than diagnostic purposes, the self-report version was used without obtaining corroborating evidence from another observer. However, those scores were useful in that the potential presence of attention deficits were minimally corroborated if formal diagnosis had not been obtained; response patterns and T-scores of those participants not having a formal diagnosis were reviewed to determine whether to include the respective CPT scores in the final analysis. The long version was chosen in an effort to obtain the most accurate profile possible. Since the majority of participant testing involved use of a computer, the paper form of the CAARS was selected as opposed to an online administration version to provide participants a computer "screen break."

Reliability coefficients for the long self-report form were satisfactory with reliability coefficients ranging between .81 and .89. Exceptions included male DSM hyperactivity/impulsivity symptoms ($\alpha = .64$), male DSM total symptoms ($\alpha = .78$), and female DSM hyperactivity/impulsivity symptoms ($\alpha = .75$) (Conners, Erhardt, and Sparrow, 1999, p. 60). Standard Error of Measurement Scores ranges were presented as between 1.48 and 3.02 for all measures with a majority of the scores between 2.23 and 2.64 (Conners et. al., 1999, p. 63).

These values were found to be acceptable for the purposes of this study because the data were not used for diagnostic purposes. Confirmatory factor analysis established the CAARS Long Self-Report form met good fit standards using a four-factor structure (Inattention/Memory Problems, Hyperactivity, Impulsivity/Emotional Lability, and Self-Concept Problems) with fit indexes ranging from .977 to .984, which was also found to be nearly identical across both age and gender (Conners et. al., 1999, pp. 67-68). Discriminant validity was found to be sufficient using the ADHD Index with an overall correct classification rate of 73%, which means the ADHD Index could be used as an initial screening measure leading to further diagnostics (Conners et. al., 1999, p. 70).

Materials

The researcher used the song *In a Mellow Tone* by Count Basie, which was played in the background during the music condition. The Count Basie *In a Mellow Tone* jazz selection was chosen for testing as it was likely to ensure participants' unfamiliarity with the selected piece, jazz music has not typically been associated with the Mozart Effect, and the work had familiar instrumentation and included the use of a drum set. The drum set ensured the consistent presence of the beat in this musical selection.

The researcher manipulated the selected music for administration purposes. The original tempo of the piece was approximately mm = 98; this was manipulated using Audacity 1.3 Beta (software program) to be approximately mm = 120 (actual tempo mm = 124). Mm references beats per second; a tempo of mm = 120 would have 2 beats per second whereas a tempo of mm = 60 would have 1 beat per second. The tempo was changed from mm = 98 to mm = 124 because the researcher witnessed previous students with attention deficits using background music around this tempo prior to this study; hence the tempo of mm = 124 seemed a reasonable equivalent. A loop was then created and inserted in the original song with the intent that it should not be “obvious” to the listener that the song was looped and made musical “sense.” The loop was added so the piece would be 14 minutes in length. The selection was played on a sound system (iPod and a stand-alone speaker system or a CD player) separate from the laptop; volume levels were set by the researcher to personal comfort level for background music listening at the beginning of testing. Participants were then asked if the music level was comfortable individually due to anticipated differences in hearing ability. All participants either confirmed the level of sound as comfortable or asked for minor adjustments (i.e. “just a little louder”). If adjustments were made to the volume, the dial was returned to its original position after the participant completed testing.

Each CPT was administered on a HP 2420 Netbook provided by the researcher. The same netbook was used for all test administrations. A Microsoft Wireless Comfort Desktop 5000 keyboard was used instead of the netbook keyboard. The external keyboard was used to prevent technical issues; participants in the pilot study were not fully depressing the spacebar on the laptop due to the lower profile of the spacebar key. The external keyboard was found to be more sensitive and was utilized for the entirety of this study.

Design

The study design included an initial condition with no or minimal treatment while allowing participants to see the test and ask questions before administration in the other two conditions. Due to limited literature, it was unknown if the ADHD group would respond similarly to the sound stimuli as did the typical group. Utilizing the initial condition for this purpose was suggested in the protocol design process and supported in the literature (Chambless & Hollon, 1998; Saville & Buskist, 2005). Hence, the initial condition was used as a point of comparison to see the effect of sound conditions on impulsivity levels and was included as part of the analysis.

Each participant was administered the Continuous Performance Test (CPT) with the researcher present; the initial condition was utilized to confirm homogeneity between the typical and ADHD groups. Each participant was then moved to the formal testing area, where the CPT was administered in both a music condition and a silence condition. Participants were assigned the initial sound condition using stratified random assignment. Three measures of impulsivity were provided by the CPT: Commissions, Hit Reaction Time, and Perseverations. Each impulsivity measure was assessed using a software program that utilized a continuous scale to determine impulsivity outcomes. Assessment criteria for each impulsivity measure are defined below and based on the definitions in the CPT Technical Manual (Conners & MHS Staff, 2004):

Commissions: Number of responses to non-target (X)

Hit Reaction Time: Mean response time in milliseconds for all target responses in all six blocks, which are divisions in place to see consistency over time

Perseverations: A response occurring less than 100ms following a stimulus

Analysis of Results

Due to normality issues, T-scores calculated by the CPT were used for the analysis as opposed to raw scores as the dependent variable measure. There were three potential CPT measures that could have been used as dependent variables: Commissions, Hit Reaction Time, and Perseverations. High correlations in these three CPT measures required further analysis to determine whether to include all 3 measures in the analysis due to multicollinearity concerns. Bivariate correlations between initial condition scores were used to quantify the relationships between the CPT measures; Commissions were significantly correlated with both Hit Reaction

Time and Perseveration measures (see Table 5). Regression was used to reveal high Squared Multiple Correlations (SMC)—calculated from Tolerance measures—with values ranging from .50 to .84 (see Table 6). Tabachnick and Fidell (2013) stated that covariates with SMC values higher than .5 may be eliminated from further analysis due to high correlation with the dependent variable(s) (p. 203). Therefore, the CPT measures Hit Reaction Time and Perseveration were determined to be assessing the same thing as the CPT measure Commissions. Thus, Hit Reaction Time and Perseveration were removed from the analysis. A resultant Two-Way Analysis of Variance (ANOVA) with Repeated Measures using CPT Commission scores as the dependent variable and Group and Condition as the independent variables was computed to determine whether a significant difference existed in impulsivity scores (CPT Commission scores) by Group (Typical versus ADHD groups) and by Conditions (Initial versus Music versus Silence Condition). The null hypotheses were as follows:

Hypothesis 1: There will be no significant difference in impulsivity scores by group, Typical group and the ADHD group.

Hypothesis 2: There will be no significant difference in impulsivity scores by condition, initial versus music versus silence conditions.

Hypothesis 3: There will be no interaction effect between the factors of group and condition.

Table 5

Initial Bivariate Correlations for CPT Measures

Measure	Commissions	Hit Reaction Time	Perseverations
Commissions	1.00	-.51	.51
Hit Reaction Time	-.51	1.00	.02
Perseverations	.51	.02	1.00

Note: *N* = 51 for this analysis

Table 6

Squared Multiple Correlation (SMC) Values as Compared to Commission Scores from the Initial Condition

Measures	SMC
Hit Reaction Time: Initial	.79
Hit Reaction Time: Music	.84
Hit Reaction Time: Silence	.84
Perseverations: Initial	.53
Perseverations: Music	.50
Perseverations: Silence	.59

CHAPTER 4: RESULTS

Data were collected to test the following null hypotheses:

Hypothesis 1: There will be no significant difference in impulsivity scores by group, typical group and the ADHD group.

Hypothesis 2: There will be no significant difference in impulsivity scores by condition, initial versus music versus silence conditions.

Hypothesis 3: There will be no interaction effect between the factors of group and sound condition.

In this chapter, discussion of the data analyses is presented.

Data were collected on a sample of N = 51, with an n = 26 for the typical group and an n = 25 for the ADHD group. Data were screened for accuracy and tested for normality, order effect, linearity, and homoscedasticity. Excessive normality issues were found among the raw data, with few of the measures passing the Shapiro-Wilk or the Kolmogorov-Smirnov normality tests. It was determined to use the corresponding raw data T-scores for computation purposes. These data were normalized in comparison with the CPT normative group. Outliers were detected and removed from the Commissions Pretest measures with 15% Winsorization of scores; the Winsorization procedure outlined by Howell (2013) was used in this process. No outliers were detected in the other two condition scores; the Commissions measures for initial, music, and silence conditions met the criteria for skewness, kurtosis, and normality after transformation of the Commission pretest measures explained above. Results for these tests are displayed in Table 7.

Table 7

Normality Test Results for Commissions Measures

Measure	Group	Mean	*SD*	Skewness	Kurtosis	Shapiro-Wilk Statistic	*df*	Sig.
Commissions Initial	Typical	54.21	8.92	.73	-.59	.951	26	.248
	ADHD	60.71	9.83	.32	-1.57	.929	25	.081
Commissions Music	Typical	57.68	12.08	.08	-.43	.983	26	.935
	ADHD	63.86	12.01	-.97	-1.05	.930	25	.087
Commissions Silence	Typical	57.67	12.65	.60	.12	.976	26	.784
	ADHD	66.28	10.44	-.31	-.81	.971	25	.662

Order effect was analyzed using a One-Way ANOVA with repeated measure; the dependent variables were the scores from the 3 conditions (initial, music, and silence), and the independent variable was the randomized condition. The randomized condition was dummy coded in the data set with 1 receiving the music condition before the silence condition and 2 receiving the conditions in the opposite order. No significant differences were found between the randomized conditions of music (M = 60.28, SE = 2.09) and silence (M = 59.70, SE = 2.13) with F (1, 49) = .04, p = .84.

Bivariate linearity was analyzed using scatterplots. There were no detectable patterns in the residuals. Homoscedasticity was confirmed using Box's M (p = .07) and Levene's Test (see Table 8). Sphericity was also validated using Mauchly's W (p = .43) with all dependent variables being independent.

Table 8

Levene's Test of Equality of Error Variances for Commission Measures by Condition

Measure	*F*	*df*	*df* error	*p*
Initial	1.37	1	49	.25
Music	.02	1	49	.89
Silence	.54	1	49	.47

Hypothesis 1: There will be no significant difference in impulsivity scores by group.

Analysis of a Two-Way ANOVA with repeated measure revealed a significant difference between the typical group (*M* = 56.52, *SE* = 1.96) and the ADHD group (*M* = 63.62, *SE* = 2.00) with *F* (1, 49) = 6.42, *p* = .02, *d* = .72, 95% CI [-12.73, -1.47]; the typical group exhibited lower Commission scores than the ADHD group with a mean score difference of 7.1. Therefore, the null hypothesis was rejected with medium to large treatment effects and a significant difference between groups. The typical group had lower average T-scores in comparison with the ADHD group in all conditions, which equates to better performance in that the typical group "hit" fewer Xs (i.e. non-targets) than the ADHD group. The typical group exhibited lower impulsivity than the ADHD group as evidenced by the Commission mean scores.

Hypothesis 2: There will be no significant difference in impulsivity scores by condition.

Analysis of a Two-Way ANOVA with repeated measure revealed a significant difference between sound conditions with *F* (2, 98) = 8.22, *p* = .001, *d* = .82. Pairwise comparisons with Bonferroni correction were calculated; the initial condition mean scores (*M* = 57.46, *SE* = 1.31) were significantly lower than both the music condition mean scores (*M* = 60.77, *SE* = 1.69) with a mean difference = -3.30, *p* = .03, 95% CI [-6.41, -.20] and the silence condition mean scores (*M* = 61.97, *SE* = 1.63) with a mean difference = -4.51, *p* = .001, 95% CI [-7.30, -1.72]. There was no significant mean score difference between the music condition and the silence condition (mean difference = -1.21, *p* = .80, 95% CI [-3.86, 1.45]). The null hypothesis was rejected with a large treatment effect due to a significant difference among conditions. It appears that participants had the best performance during the initial condition in that T-scores were significantly lower in the initial condition. Performance was statistically equivalent in both the music and the silence condition; both conditions had higher Commission mean scores—which equates to a poorer performance—than the initial condition. It would appear that the music condition was not different from the silence condition when comparing across conditions, while the initial condition resulted in the best performance among participants in the typical and the ADHD groups.

Hypothesis 3: There will be no interaction effect between the factors group and condition.

Analysis of a Two-Way ANOVA with repeated measure revealed no significant interaction between the factors of group and condition with F (2, 98) = .66, p = .52, d = .23. As no interaction was found between the two factors, the decision was to fail to reject the null hypothesis with small treatment effect. The factors of group and condition appear to be independent. The Commission score mean differences between groups were not significant across the initial, music, and silence condition.

Analysis Summary

A significant difference in Commission scores was found by group. The typical group exhibited significantly lower Commission scores than the ADHD group, which means the typical group hit fewer Xs during the CPT administrations than the ADHD group. Fewer Xs and lower Commission scores equated to lower levels of impulsivity for the typical group in comparison to the ADHD group.

When considering the data across conditions, only the initial condition was found to be significantly different from both the music condition and the silence condition with the music and the silence conditions being statistically equivalent. Background music was equivalent to silence as judged by Commission mean scores among conditions.

Both the factors of group and condition appear to be independent as no interaction was found. Hence, the ADHD group and the typical group Commission mean score differences were not significant across the three conditions. There appears to be no significant interaction between the factors of group and condition. No significant Commission mean score differences were found between group across conditions. The results above are interpreted in Chapter 5.

CHAPTER 5: DISCUSSION

Data were collected to determine whether playing music in the background while taking a Continuous Performance Test (CPT)—a repetitious computer task used as part of the ADHD diagnosis process—had a significant effect on impulsivity in those with ADHD. The current literature base indicates mixed results concerning the use of background music during a variety of tasks; however, there are few studies regarding the impact of background music on specific populations and a disparate amount of research involving students with attention deficits. This study was the first to assess the effect of background music on one specific indicator of ADHD, and also the first to ascertain the effect of background music on college students with ADHD. It can be concluded, from post-analyses, that the effect of background music was significant between groups; a significant difference was also found between conditions with no interaction of group by condition.

Analyses were conducted to determine whether significant differences existed between groups (a typical group with no history of ADHD and an ADHD group with a history of attention deficits), among conditions (an initial condition in which the researcher was present during the CPT, a music condition in which music was played in the background during the CPT, and a silence condition where the CPT was taken in silence), and between groups by condition. Significant differences in Commission mean scores were found by group; the typical group had lower Commission mean scores. Lower Commission scores equated to lower impulsivity levels and better performance as fewer nontargets (Xs) were hit during the 14-minute test. Because the Conners' CPT II scores have been found to differentiate between the typical population and those with ADHD (Conners & MHS Staff, 2004, p. 65), it was expected that significant differences would exist between groups as the CPT has been developed to help clinically diagnose students with attention deficits. Because students with ADHD tend to have difficulty concentrating, focusing, and tend to avoid tasks that require sustained mental effort, etc. (Altenmaeller, 2007; American Psychiatric Association, 2013; Baird et al., 2000; Jensen, Martin, & Cantwell, 1997a; Willcutt et al., 2012), higher mean Commission scores were expected of those with ADHD as the scores have been used as an indicator for diagnosis (Conners & MHS Staff, 2004).

Significant differences were also found by condition, with the initial condition being significantly lower than both the music and the silence conditions. Participants had lower Commission mean scores in the initial condition, which equated to better performance. There was no significant Commission mean scores difference between the music and silence condition. Participant scores in both the music and silence conditions were higher as compared to the initial condition. The Yerkes-Dodson Law of Arousal (Yerkes & Dodson, 1908) and Optimal Stimulation Theory (Zentall & Zentall, 1983) may account for these differences.

In the initial condition, each participant finished the intake survey and began the CPT immediately thereafter. The researcher was present in the testing room during this process. Mehrabian (1977) stated that higher arousal is exhibited during sudden or surprising situations with lower arousal during more calm or monotonous conditions. Since the researcher was present in the initial testing situation, this would qualify as a moderate level stimulus, thus possibly creating a heightened arousal state in participants. According to Yerkes-Dodson, a moderate level stimulus is ideal for habit formation (Yerkes & Dodson, 1908). The presence of the researcher combined with an unfamiliar testing procedure in an unfamiliar space may have caused an increase in the participants' arousal to a moderate level, which positively affected the amount to which all participants attended to the test during the initial condition.

For the ADHD group specifically, the initial condition scores were consistent with the Optimal Stimulation Theory (Zentall & Zentall, 1983) in that the scores were lower in the initial condition when compared to the other two sound conditions. Abikoff, Courtney, Szeibel, & Koplewicz (1996) posit that distractibility of children with ADHD may be a way to compensate for underarousal as they search for “stimulation or novelty" (p. 238) as part of the Optimal Stimulation Theory. The initial condition would be a novel situation in an unfamiliar setting that would quickly lose its uniqueness after repeated administrations of the same test despite different sound conditions. It could be hypothesized that initial condition Commission mean scores were lower due to higher levels of arousal during the first test administration. The playing of music in the background during the administration of the CPT in the music condition did not enhance arousal to the extent that Commission mean scores were lower than in the initial condition. The Commission mean scores in the music condition were equal to Commission mean scores from the silence condition. Music and silence were not as effective in arousal level maintenance as the researcher’s presence in the initial condition. Reardon and Bell (1970) had a similar confound as it was uncertain whether the decrease in self-stimulation behaviors of boys with severe intellectual disabilities was due to the provided music or the novelty of having sound in the room.

Genre and preference could be factors to the equivalence of Commission mean scores in the music and silence condition. Arousal levels are individualized. Some researchers have found some benefit to those with special needs—including those with ADHD—with the music of Mozart (Pratt, Abel, and Skidmore, 1995; Savan, 1998; Savan, 1999) while others have found benefits to those with ADHD using rock music (Abikoff et al., 1996; Cripe, 1986; Scott, 1970; Wiebe, 2007). Still others have found music to be a distraction when played in the background or have obtained mixed results (Anderson & Fuller, 2010; Fogelson, 1973; Freeburne & Fleischer, 1952; Henderson, Crews, & Barlow, 1945). Music preference could further affect the arousal level, with researchers finding preferred music positively influence mood and states of arousal (Lesiuk, 2010), stress reduction (Jiang et al., 2013), and results of an arithmetic task (Abikoff et al., 1996). The music selection played during the music condition may not have been able to raise the arousal levels of all participants consistently, which could explain the music condition mean scores being equivalent to those in the silence condition.

Both the factors of group and condition appear to be independent as no interaction was found. Hence, the ADHD group and the typical group Commission mean score differences were not significant across the three conditions.

Study Limitations

Limitations to this study included the use of a participant self-report for identification of ADHD. Sample size was not as large as intended and the use of a convenience sample was a study limitation. The use of an office environment, although relatively removed from high traffic areas, was a limitation to this study. Finally, iPod usage to provide the music during the ADHD group testing became problematic and was a limitation. These limitations have been explained further in the paragraphs that follow.

A sample of participants with ADHD comprised one of two study groups. Participants for the ADHD group were identified through a self-report form with no corroboration from other observers. Because clinical diagnosis was not required, there was some resultant confusion with two participants. These participants were compensated for their time but were removed from the data set due to self-perceived attention deficits (i.e. “I feel I am distractible and have difficulty focusing”) as opposed to a history of deficits (i.e. “I was tested and recommended for further evaluation”). The remaining ADHD sample did have scores on both the CAARS rating scales and the CPT consistent with those formally diagnosed with ADHD. However, having further corroboration using an observer scale—similar to those required for a clinical diagnosis or requiring a clinical diagnosis to participate—would have strengthened the study and assisted in identifying participants’ diagnostic subtype labels (i.e. hyperactive/impulsive, inattentive, combination), comorbid conditions (i.e. depression, anxiety, Oppositional Defiance Disorder), and other conditions frequently diagnosed with ADHD.

The sample size for this study was ample for this analysis; however, the ADHD group was not recruited with the intention of equal number of diagnostic subtype (i.e. hyperactivity/impulsivity, inattention, or combined type). Some participants knew their diagnosed subtype while others did not. Identification of ADHD subtypes could have provided additional information that would have been useful for interpretative purposes. Participants diagnosed with an inattentive subtype of ADHD may have been able to continue focus, for example. Due to added stimulation, the inattentive subtype—who are more prone to distraction, lack of attention to detail, and other related behaviors (American Psychiatric Association, 2013)—may respond differently to music stimuli than a different subtype. The added stimulation could be a benefit by limiting the outside distractions using sound as type of barrier; however, the music also provides novelty to the situation, which would help the inattentive type persevere in the task. By contrast, music has the potential to induce overstimulation for those diagnosed with hyperactivity/impulsivity. This subtype is more prone to excessive motor activity, restlessness, and other related behaviors (American Psychiatric Association, 2013). Identification of ADHD subtypes could have provided additional information that would have been useful for interpretative purposes; however, any potential differences were not analyzed as the subtype classification was not consistently available. Future studies should take diagnostic subtype into consideration, as it may be a factor in both reaction to and focus on presented stimuli.

Another issue was the use of a convenience, rather than a random, sampling procedure. Participants volunteered to participate. Utilizing volunteers, as opposed to random selection from the population, means the probability of selecting a representative sample of the population is highly unlikely. A random sample would likely garner different results and should be a consideration for future studies.

This study was conducted in an office environment. Although the traffic in this area was minimal, there were still situations in which the environment was not completely silent (i.e. hall noise, sounds from a neighboring office, etc.). Outside noises may have affected the participants. Sounds transmitted from outside sources and heard in the testing area can cause distractions. Participant distractions can result in an increase in Commission scores (i.e. distracted participants may have hit more nontargets). Poor sound condition control could have deleterious effects on the silence condition. The silence condition may not have been truly silent. A soundproof room would have been ideal, but was not an option for this study.

During the typical group testing period, two CD players ceased functioning in the middle of testing. A speaker with an iPod was used for the attention deficit group to prevent further technical difficulties. Some participants mentioned attempts to see the iPod screen, which was visible from the testing area, to see how much time remained in the test as the elapsed performance time and total performance time is displayed on the iPod screen. The iPod screen darkens shortly after the play button is depressed, but it was still possible to see the time left in the music selection. The time display and the consequent desire for participants to know how much time was left in a monotonous test may have affected the participants in either positive ways (i.e. it is almost over) or negative ways (i.e. missing targets on the screen while attempting to read the time on the iPod).

Suggestions for Future Research and Implications

Participants in the typical group anecdotally stated they could not focus in the music condition after test completion, but participants in the attention deficit group typically had a different reaction. It was also noted by the researcher sitting outside of the room that participants were depressing the spacebar with the music's beat as the spacebar click was audible. The act of depressing a spacebar to the beat of music is an act of entrainment—a coordinated rhythmic movement to a pulse. Consideration should be given to a mixed methods study involving both quantitative measurements and qualitative statement analysis to see if the perceived effects of entrainment match the data quantifying behaviors associated with ADHD in a research condition. By analyzing comments of the participants, possible correlations may emerge between positive or negative comments regarding entrainment effects.

A larger and more comprehensive, randomly selected sample would also be recommended. Although the sample was large enough for the proposed analysis, more detailed sample selection may show better the potential effects for those having ADHD. Recruiting specifically by diagnostic subtype (i.e. hyperactive/impulsive, inattentive, and combined type) would be ideal as the characteristics of each subgroup are very different. The effects of music on different diagnostic subtypes may also vary but were not examined in this study. A randomly selected sample should also be a consideration, as it would likely be more representative of the true population. Hence, generalizability would be more appropriate as the results from a normal distribution would reflect the actual population distribution. The sample for the current study was not randomly selected, which means different results are likely in subsequent studies and generalizability is limited.

Future research could address the effect of music on time perception and preference. Most of the participants anecdotally mentioned they enjoyed the music selection and felt that time seemed to go faster during the music condition. The distortion of time perception is consistent with the work of North and Hargreaves (1999) and Oakes (2003) in that many of the participants felt the music condition “seemed to go faster than the silence condition.” There may also be a preference factor, especially in repeated tasks or tasks considered unpleasant. This study did not take into account music preferences, which was a large factor in the studies of Abikoff et al. (1996) and Lesiuk (2010). Abikoff et al. (1996) posited “… the level of appeal, rather than the mere presence of stimulation, appears to be the critical influential feature for children with ADHD" (p. 243). Lesiuk (2010) found preferred music affecting participants’ focus level by keeping the participants calm and relaxed during high-cognitive demand tasks. Robb (2003) stated that music can have an impact on arousal; future research could address the impact of preference and arousal in both repetitious and academic tasks. More research is needed to see if music preference would further enhance or deter the results of those with ADHD and possibly those of the typical group.

Further investigation is needed to discover the effect of background music use during educational tasks (i.e. math problems, reading, homework completion, etc.). Researchers could also explore whether students, especially those accustomed to background sound, are able to focus better with or without background music.

Music education has a role in this research as music educators tend to be the musical guides of their respective schools. Music teachers become the conduit for further music exploration and discovery, as technology facilitates students' ability to listen to isolated music genres. Due to the scant literature base, it is unknown what style music might have the most impact with students diagnosed with ADHD or what musical elements could have an effect. Music educators should discuss potential effects of music with their students and introduce their students to a wide variety of music, especially to those having ADHD. This may help students make conscious decisions regarding their music use and the music to which they listen, while potentially providing students with attention deficits more effective musical options.

Research Summary

A significant main effect difference was found by group such that the typical group performed in a superior fashion as compared to the ADHD group based on Commission mean scores. The typical group exhibited significantly lower Commission scores, which are connected to impulsivity levels, than the ADHD group. Additionally significant main effect differences were found by condition.

Only the initial condition was found to be significantly different from either the music condition or the silence condition. Music and silence condition mean scores were statistically equivalent. The background music condition was deemed equivalent to the silence condition in terms of task performance as determined by Commission mean scores. Both the factors of group and condition appear to be independent as no interaction was found. Hence, the ADHD group and the typical group Commission mean score differences were not significant across the three conditions.

This was the first study to investigate the effect of music on one specific indicator of attention deficits, as well as the first study to investigate the effect of background music on college students with attention deficits. There was a difference between students with and without attention deficits in these conditions. Much work is needed to see if these findings can be replicated and continuing analysis on this data set for other indicators of ADHD.

APPENDIX A: IRB APPROVAL DOCUMENT

THE UNIVERSITY OF ARIZONA.

Human Subjects Protection Program

1618 E. Helen St.
P.O. Box 245137
Tucson, AZ 85724-5137
Tel: (520) 626-6721
http://orcr.arizona.edu/hspp

HSPP Correspondence Form

Investigator: Laura Dunbar, Graduate Student **Department: Fine Arts**

Advisor: Donald Hamann

Project No./Title: 13-0112-00 The Effect of Music on Impulsivity of College Undergraduate Students with Attention Deficits

Expiration Date: No Expiration

IRB Committee Information

Administrative Action **Administrative Review – New Project**

FWA Number: FWA00004218

Documents Reviewed Concurrently

F200 (signed 2013-01-12; revised 2013-02-18)

Consenting Instruments:

ICF (version 2013-02-18)

F107 (version 2013-01-31)

Recruitment Materials:

Flyer

Data Collection Instruments:

CAARS

Impulsivity Questionnaire

Participant Materials:

Sign Out

Other:

CV Dunbar

Determination

Approved as submitted effective as of the signature date below

Comments

- **Recruitment Site Authorization Requirement:** Before posting any flyers/advertisements on private bulletin boards OR University of Arizona bulletin boards outside of the Principal Investigator's home department OR physically recruiting from any location, written site authorization must be obtained. Please retain this authorization in your research records.

Regulatory Determination(s)

- **Exempt Approval 45 CFR 46.101(b)(2):** Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior.

Reminders: No changes to a project may be made prior to IRB approval except to eliminate apparent immediate hazard to subjects.

Arizona's First University – Since 1885

Title: HSPP Correspondence Form
Form version: 02-11-2013

Digitally signed by Sheryl Wurl
DN: cn=Sheryl Wurl, o=HSPP, ou=Director, Human Subjects Protection Program, email=swurl@email.arizona.edu, c=US
Date: 2013.02.18 15:24:45 -07'00'

Sheryl Wurl, PhD Date
Director, University of Arizona IRB

SW:ace

cc: Scientific/Scholarly Reviewer

- No changes to a project may be made prior to IRB approval except to eliminate apparent immediate hazard to subjects.

APPENDIX B: APPROVED CONSENT FORM

APPROVED BY UNIVERSITY OF AZ IRB.
THIS STAMP MUST APPEAR ON ALL
DOCUMENTS USED TO CONSENT SUBJECTS.
DATE: 02/18/13

The University of Arizona Consent to Participate in Research

Study Title: The Effect of Music on Impulsivity of College Undergraduate Students with Attention Deficits

Principal Investigator: Laura Dunbar, BM, MM

Sponsor:

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate. Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to participate.

This form is meant the participants to read through and sign.

1. Why is this study being done?

The purpose of this study is to investigate the effect of music listening on impulsivity. Participants will include students with ADHD and students with typical needs; each participant will use a computer to take a Continuous Performance Test (CPT) in a silence condition and a music condition.

2. How many people will take part in this study?

We hope to enroll 60 undergraduate students with typical needs and 60 undergraduate students with attention deficits in the study.

3. What will happen if I take part in this study?

- After the recruitment period is over, an appointment would be set up with the researcher via email.
- If you are currently taking medication for attention deficits, you will be asked to not take the medication on the day of the test.
- At the appointment, you will be asked to complete a computerized test a total of three (3) times: once with the researcher, and two times alone in a room with the researcher outside of the room. For one test, music will be playing in the background. A survey and a snack will be given to you between the second and third test, and the entire session will last a little over an hour.

4. How long will I be in the study?

The testing for the study appointment will take approximately one hour.

5. Can I stop being in the study?

Your participation is voluntary. You may refuse to participate in this study. If you decide to take part in the study, you may leave the study at any time. No matter what decision you make, there will be no penalty to you and you will not lose any of your usual benefits. Your decision will not affect future relationship with The University of Arizona. If you are a student or employee at the University of Arizona, your decision will not affect your grades or employment status.

6. What risks, side effects or discomforts can I expect from being in the study?

If you are asked to skip your medication for your attention deficits, you may have increased symptoms due to not taking their medication. There are no additional risks associated with completing the surveys and computer tests.

7. What benefits can I expect from being in the study?

There are no direct benefits to participants of this study.

8. What other choices do I have if I do not take part in the study?

You may choose not to participate without penalty or loss of benefits to which you are otherwise entitled.

9. Will my study-related information be kept confidential?

Efforts will be made to keep your study-related information confidential. Only research staff will have access to your responses. However, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by state law.

Data gathered from this project may be published in academic journals, or may be presented at academic conferences. If this occurs, you will not be identified, and all of your information will remain confidential within the research staff.

10. What are the costs of taking part in this study?

Transportation to and from the University will be the responsibility of the participant.

11. Will I be paid for taking part in this study?

You will receive $10 (cash) for taking part in this study.

12. What are my rights if I take part in this study?

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study.

You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled.

An Institutional Review Board responsible for human subjects research at The University of Arizona reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

13. Who can answer my questions about the study?

For questions, concerns, or complaints about the study you may contact Laura Dunbar, 520-626-0093, or her advisor, Dr. Donald Hamann, 520-621-3231.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact the Human Subjects Protection Program at 520-626-6721 or online at http://orcr.arizona.edu/hspp.

Signing the consent form

I have read (or someone has read to me) this form, and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

Printed name of subject	Signature of subject
	AM/PM Date and time

Investigator/Research Staff

I have explained the research to the participant or the participant's representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or to the participant's representative.

Printed name of person obtaining consent	Signature of person obtaining consent
	AM/PM Date and time

APPENDIX C: INTAKE SURVEY

Number __________ Initial Condition __________

Please circle your answer.

Gender: Male Female

Age: 18 19 20 21 22 23 24

Year in college: Freshman Sophomore Junior Senior Fifth-year or beyond

Have you been diagnosed by a doctor as having attention deficits: Yes No

If yes, which type best describes the attention deficit?

Inattention Hyperactivity Impulsivity Unsure

Are you currently taking medication for attention deficits: Yes No

If yes, did you take your medication today? Yes No

If no, have you ever taken medications for attention deficits: Yes No

If you are currently taken medication or have taken medication in the past, how long have you/were you taking medication?

0-2 years 3-5 years 6-8 years longer than 9 years

Do you have any other conditions in addition to attention deficits?

Anxiety Conduct Disorder Depression Learning Disability

Oppositional Defiance Substance Abuse Unknown None of These

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