A SINGLE-SUBJECT STUDY ON LISTENING TO STUDENT-SELECTED MUSIC THROUGH HEADPHONES FOR STUDENTS WITH ADHD

by

Jennifer Renee Royster Ramey

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

The purpose of this study was to determine the effects that self-selected music have on the working memory of fifth grade students with an ADHD diagnosis. A single-subject ABACAC design was used, and a convenience sample of five fifth-grade students from a rural central Virginia middle school participated in the study. An on-line working memory N-back task (Cognitive Fun!, 2008) was used to measure the working memory of each participant under the conditions of no music, teacher-selected music listened to through headphones, and self-selected music listened to through headphones. The results of this study found that one participant experienced a significant increase in working memory while listening to teacher-selected (classical) music. No other significant effect on the working memory of fifth grade students while listening to self-selected music as compared to no music or teacher-selected music were found. However, further research is necessary to determine if self-selected music might affect working memory in older students.

Keywords: Music, ADHD, Mood, Attention, Single-subject design

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Dedication

This dissertation is dedicated to my husband, David Scott Ramey, who has supported me throughout this process during endless hours of work and financial obligations. Without your support and faith in me, I would not have been able to complete this process. Your support and dedication are recognized and truly appreciated.

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I would also like to thank the school system that allowed me to conduct my research in your building and the parents who agreed to allow their children to participate in my study. A special thank you goes out to the teacher who assisted me to collect the data needed for this study. Her dedication to my project and the endless hours that she worked with our students was priceless and truly appreciated.

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List of Abbreviations

Attention Deficit Hyperactivity Disorder (ADHD)

Functional Magnetic Resonance Imaging (fMRI)

Institutional Review Board (IRB)

Intelligence Quotient (IQ)

Percentage of Non-overlapping Data (PND)

CHAPTER ONE: INTRODUCTION

Overview

Since the passage of the Education for All Handicapped Children Act in 1975, children with disabilities have been educated in general education classrooms across the United States. However, meeting the needs of students with disabilities in the general education classroom can be challenging for teachers (Gaastra, Groen, Tucha, & Tucha, 2016). These challenges are often confounded with misconceptions and limited knowledge of the needs of students with disabilities among new teachers (Kikas & Timostsuk, 2016). Meeting the needs of students with Attention Deficit Hyperactivity Disorder (ADHD) in the classroom can be achieved through appropriate use of strategies designed to equip these students with what they need to be successful (Bussing et al., 2016; Cook, Bradley-Johnson, & Johnson, 2014; Gaastra et al., 2016; Zentall et al., 2012). There are many unique empirically based strategies that have been found to aid the performance of students with ADHD (Gaastra et al., 2016). These strategies may include assistance with self-regulation (cognitive, behavioral, social/emotional responses) (Gaastra et al., 2016), as well as environmental controls such as sensory stimulation and separate classroom environments (Imerja et al., 2013). Such strategies assist students with ADHD to focus, perform better on tests and quizzes, and behave appropriately in the classroom (Cook et al., 2014; Gaastra et al., 2016; Zentall et al., 2012). Among these strategies, music has been used in numerous studies for multiple purposes, including obtaining higher test scores and better behavior for students with and without disabilities (Cabanac, Perlovsky, Bonniot-Cabanac, & Cabanac, 2013; Dosseville, Laborde, & Scelles, 2012; Pelayo, 2014; Rauscher, Shaw, & Ky, 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). This study attempted to discover whether listening to self-selected music through headphones effects the working memory of fifth-grade students with ADHD.

Chapter one begins with a limited discussion of ADHD historical background. Next, chapter one address two theories that the study is based upon, as well as information regarding special education in public schools, ADHD, and executive function. Then, this chapter addresses barriers to success for students with ADHD, working memory, and strategies for success. Then, the problem statement is presented with supporting empirical research from previous studies, along with the purpose statement and the significance of the study. Finally, the research questions are introduced, and definitions pertinent to this study are given.

Background

This study examined how music can affect the working memory of fifth-grade students with ADHD. As mandated by the Individuals with Disabilities Education Act (IDEA, 2004), which is an update of PL 94-142 ("Thirty-five," 2010), students with ADHD are often served as students with disabilities under the special education category of Other Health Impairment (Bussing et al., 2016; Cho & Blair, 2017; Regulations, 2010). The Diagnostic and Statistical Manual of Mental Disorders (2013) describe the essential features of ADHD as follows:

> A persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development. *Inattention* manifests behaviorally in ADHD as wandering off task, lacking persistence, having difficulty sustaining focus, and being disorganized and is not due to defiance or lack of comprehension. *Hyperactivity* refers to excessive motor activity (such as a child running about) when it is not appropriate, or excessive fidgeting, tapping, or talkativeness. (p. 61)

Throughout the history of education, students with disabilities, including those with ADHD, have been a challenging group of students to successfully reach academically and benefit from unique strategies applied appropriately (Lee, Wehmeyer, & Palmer, 2010; Lessing & Wulfsohn, 2015). Students with ADHD often have difficulties with attention and behaviors that can affect their ability to interact socially, attend school regularly, and be successful academically (Bussing et al., 2016). Students with ADHD may require an optimal level of stimulation to be able to focus on a task or information (Hebb, 1955; Pelham et al., 2011; Schlosberg, 1954; Zentall et al., 2012). For this study, self-selected music, teacher-selected music (classical), and no music was added to a working memory activity to determine whether the conditions affect working memory differently. The working memory of students with ADHD was assessed with an online instrument to determine if working memory improves when listening to student-selected music as opposed to no music or teacher-selected (classical) music. The working memory assessment was applied to the students under the three conditions. Then, data was collected and analyzed for differences.

Theories

Several theories support that the extra stimulation of music may affect the working memory of students with ADHD. The first theory is the optimal stimulation theory, which states that one may be bored with too little stimulation or overwhelmed with too much stimulation (Hebb, 1955; Schlosberg, 1954). The theory of optimal stimulation applies to the current study as students with ADHD typically have attention difficulties that create learning and behavioral problems that can be a barrier to academic success (Bussing et al., 2016). Additionally, the Mozart effect theory suggests that listening to Mozart music may affect memory (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014). This theory is relevant to this study because children with ADHD listened to self-selected and teacher-selected music while participating in a working memory assessment to determine whether the two types of music affect working memory as compared to no music (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014).

Special Education and Public Schools

Before Public Law 94-142 (“Thirty-Five,” 2010), The Education for All Handicapped Children Act, now known as the Individuals with Disabilities Education Act (IDEA, 2004), was passed by Congress, many students with special needs, some of the most vulnerable students, were not allowed to attend public school (Pardini, 2016; Thirty-five, 2010). Neither public schools nor teachers had the knowledge or skills to help children with disabilities to be successful academically. Parents were left to their own devices to decide how to educate their children, if they were educated at all (Pardini, 2016). Parents who were once alone in overcoming the challenges of their children with little to no help are now supported through the education of their children successfully through access to public education (Pardini, 2016).

Public Law 94-142 (Thirty-five, 2010) mandates that all children receive a free and appropriate education within the least restrictive environment. After Public Law 94-142 was implemented, children with mild to severe disabilities began to be included in public school systems (Thirty-five, 2010). Since that time, several amendments and reauthorizations have strengthened the laws that protect students with disabilities, as well as strengthened the special education programs across the nation, and currently, the majority of students with disabilities receive services within the general education classroom in public school settings (Torreno, 2016).

ADHD

Research indicates that approximately 4% to 10% of children in the United States are affected by ADHD (Bussing et al., 2016; Kern, Amod, Seabi, & Vorster, 2015; Mulholland, Cumming, & Jung, 2015). With approximately 4.4 million children in the United States having an ADHD diagnosis, the disorder is a common disability among school-aged children (Iseman, 2012; Maloy & Peterson, 2015). The high number of children diagnosed with ADHD contributes to the likelihood that at least one child in each classroom will have ADHD (Iseman, 2012; Maloy & Peterson, 2015; Mulholland et al., 2015), and the majority of these children with ADHD diagnoses are males (Lessing & Wulfsohn, 2015; Maloy & Peterson, 2015).

Educating children with disabilities, including ADHD, proves to be challenging for school systems (Bussing et al., 2016; Cho & Blair, 2017; Iseman, 2012). Students with ADHD can have difficulties with social interactions, high absenteeism, grade retention, and higher dropout rates, as well as a lower likelihood of pursuing higher education (Bussing et al., 2016). Because of these difficulties, students with ADHD are more likely to experience suspensions, retention, and failures than their non-disabled peers (Cho & Blair, 2017; Iseman, 2012; Zentall et al., 2012). Additionally, children with ADHD often have difficulty beginning and/or completing higher education and carry difficulties into adulthood (Bussing et al., 2016; Iseman, 2012). Many of these challenges may be a result of difficulties with executive functioning, which affects the way a child can manage various stimuli from the environment (Brown, 2013; Iseman, 2012; Lesiuk, 2015).

Executive Function

Executive functioning difficulties can include, ". . . planning, organization, attention, and self-regulation, which contributes to their academic struggles" (Iseman, 2012, p. 2). Executive function impairments can affect one's ability to self-manage behaviors, including making choices, initiating self-care, and following directions (Brown, 2013; Lessing & Wulfsohn, 2015). Self-management of behaviors is a challenge for many children diagnosed with ADHD due to executive dysfunction (Brown, 2013; Lessing & Wulfsohn, 2015). Behavior issues that are a result of executive function impairments can often lead to learning difficulties (Brown, 2013; Lessing & Wulfsohn, 2015). Specific strategies are often effective in managing behaviors of students with ADHD and executive dysfunction (Lee et al., 2010; Lessing & Wulfsohn, 2015). One such strategy, music training, has been found to help improve executive functioning in many areas (Dege, Kubicek, & Schwarzer, 2011; Lesiuk, 2015). For example, music training has been found to assist with language development, as well as improvement in attention, impulsivity, and working memory (Dege et al., 2011; Lesiuk, 2015).

Barriers for Students with ADHD

Students with ADHD can have a myriad of barriers to academic, social, and emotional success as a result of their impulsivity and inability to remain focused (Desrochers, Oshlag, & Kennelly, 2014; Lessing & Wulfsohn, 2015; McFerran, Thompson, & Bolger, 2016). Students with ADHD also often have a high rate of comorbidity with other disorders (Lesiuk, 2015; Rickson, 2006). ADHD has a 25% to 80% comorbidity rate with other disabilities such as learning disabilities, mood/behavioral disorders, anxiety disorders, and oppositional/conduct disorder (Lesiuk, 2015; Rickson, 2006). The learning difficulties of students with ADHD can be compounded by the fact that they can become frustrated easily and react impulsively, as well as have communication and anger management issues (Desrochers et al., 2014; Lessing & Wulfsohn, 2015; McFerran et al., 2016). However, students with ADHD often have average or above average intelligence; subsequently, their difficulty in school is not typically associated with their academic abilities (Curtis, Chapman, Dempsey & Mire, 2012). Strategies to accommodate students with disabilities have been found significant to the success of these students (Lee et al., 2010; Lessing & Wulfsohn, 2015).

Working Memory

Children with ADHD often have deficits in the area of working memory (Coghill, Seth, & Mathews, 2013; Klingberg, Forssberg, & Westerberg, 2002). Working memory is the ability of a person to retain and manipulate information (Jaeggi, Buschkuehl, Perrig, & Meler, 2010; Klingberg et al., 2002). Working memory is an executive function controlled by the prefrontal cortex of the brain and is often an area of dysfunction for students with ADHD (Lesiuk, 2015; Zhao-Min et al., 2017). Working memory dysfunction can lead to academic difficulties for students with ADHD (Lesiuk, 2015; Zhao-Min et al., 2017). It is also thought to be a general measurement of cognitive ability (Coghill et al., 2013; Klingberg et al., 2002). Often children with ADHD have difficulties in numerous areas that are thought to be controlled by working memory, including problem-solving and logical reasoning (Coghill et al., 2013; Klingberg et al., 2002; Westerberg & Klingberg, 2007). Additionally, students with ADHD often have deficiencies in the functioning of their frontal lobe, which controls working memory (Coghill et al., 2013; Klingberg et al., 2002; Westerberg & Klingberg, 2007). However, the working memory of students with ADHD can be improved through training (Klingberg et al., 2002; Westerberg & Klingberg, 2007). Should working memory dysfunction be resolved for students with ADHD, many of the symptoms of ADHD may resolve along with it (Coghill et al., 2013; Klingberg et al., 2002; Westerberg & Klingberg, 2007).

For this single-subject study, working memory was used as a measure for the ability to retain and manipulate information. According to Sander, Lindenberger, & Werkle-Bergner

(2012), working memory is a person's, "ability to maintain and manipulate information to guide goal-directed behavior" (p. 2007). Working memory is used to both store and manipulate information, and it is very important in the ability to organize information (Baddeley, 1992). For this single-subject study, the effect of student-selected music on the working memory of students with ADHD was measured by online N-back tasks (Conway, Kane, & Engle, 2003; Engle, 2010; Wilhelm, Hildebrandt, & Oberauer, 2013). Online N-back tasks display words or objects in a series, and the participant pressed a key when they see the same image that was presented a specified number of times back. For example, if the task is a two-back task, the participant is asked to press a key when they see the same word or object that they saw two images back (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013). For example, Bedard et al., (2014) used a visuospatial N-back task with black squares and a white dot. The participant was to respond when the white dot was displayed in the same area the white dot had been displayed a specified number of times ago (Bedard et al., 2014). Kato, Nakamura, Kato, & Kuratsubo,(2016) used concrete two-syllable nouns printed in black ink on a white background for an N-back task. This type of instrument has been used in working memory research and is considered valid and efficient (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013). For this study, data collected from N-Back tasks was examined visually for the level of performance, trends, and variability to determine whether self-selected music has an impact on the working memory of students with ADHD.

Strategies for Success

Many empirical studies recognize effective strategies that can help students with ADHD to be successful in the classroom (Bussing et al., 2016; Cook et al., 2014; Gaastra et al., 2015; Imeraj et al., 2013; Maloy & Peterson, 2015; Zentall et al., 2012). Strategies can include both accommodations and modifications within the classroom (Batshaw, 2002). Accommodations are, "changes made in how a student has access to the curriculum or demonstrates learning" (Batshaw, 2002, p. 603). Accommodations do not change the material that is to be learned and can include group size, environmental changes, verbal prompts, and reduced assignments (Batshaw, 2002). A modification is "a substantial change in the method or scoring scale used to assess a student's academic performance or knowledge" (Batshaw, 2002, p. 738).

Findings from several empirical studies have indicated the effectiveness of music as a strategy in the classroom for students with disabilities (Cabanac et al., 2013; Dosseville et al., 2012; Rauscher et al., 1993; Zentall et al., 2012). Music played during lecture may have a positive impact on retention of information for students with and without disabilities (Crncec, Wilson, & Prior, 2006; Dosseville et al., 2012; Hallam, Price, and Katsarou, 2002). Students' ability to focus and retain more information may be related to a reduction in stress through listening to pleasant music during assessments (Cabanac et al., 2013). All students may be able to benefit from these effects, not just those who have a natural musical tendency (Cabanac et al., 2013). Listening to music while attending to memorization or test taking could even result in higher rates of information retention (Rauscher et al., 1993).

The Mozart effect is a theory that originated from a study completed by Rauscher et al. (1993). The theory states that listening to Mozart music can increase a person's spatial-temporal reasoning, thereby, increasing one's ability to retain information (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014). Rauscher et al. (1993) conducted an experiment regarding the effect music has on the spatial reasoning tasks for college-age students (N=36). Rauscher et al. (1993) used three conditions including Mozart music playing in the background, a relaxation tape playing in the background, and silence in the background. This study concluded that spatial reasoning scores were eight to nine points higher when the subjects listened to Mozart music as opposed to the other two conditions (no effect size noted) (Rauscher et al., 1993). However, many questions were left, and a myriad of researchers since that time have expanded upon this research to determine what, if any, effect Mozart or other music might have on students with and without disabilities (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Rauscher et al., 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006).

Maloy and Peterson (2015) found that external stimulation, including Mozart music and other forms of music, may have a positive effect on students with ADHD. Music can help students with ADHD to perform better academically but may have an adverse effect on the memory of students without ADHD (Maloy & Peterson, 2015). The current study as it relates to the impact that student-selected music may have on the working memory of student with ADHD is important because it adds to the body of knowledge regarding effective strategies to assist students with ADHD to be successful in the classroom and beyond.

Problem Statement

Meeting the needs of students with ADHD can be especially challenging in the classroom as many are easily distracted and have difficulty focusing (Cook et al., 2014; Gaastra et al., 2016; Zentall et al., 2012). These issues with attention, focus, and behavior can become barriers to their academic success (Cook et al., 2014; Gaastra et al., 2016; Zentall et al., 2012). The ability for students with ADHD to be able to attend to information and commit it to memory is dependent upon their working memory (Klingberg et al., 2002; Westerberg & Klingberg, 2007; Zhao-Min et al., 2017). Working memory is a person's ability to maintain and manipulate information; thus, any breakdown in this process can be a barrier to the academic success of students (Sander et al., 2012; Westerberg & Klingberg, 2007). Many teachers often have difficulty managing classroom behaviors of students with ADHD due to a lack of strategies and skills that could help address the special learning needs of students with ADHD (Gaastra et al., 2016). As a result, many students with ADHD cannot focus and maintain attention, which results in a direct effect on academic achievement (Gaastra et al., 2016).

Research indicates that implementing evidence-based strategies with students with ADHD is critical to the academic success of these students (Bussing et al., 2016; Cook et al., 2014; Gaastra et al., 2015; Imeraj et al., 2013; Maloy & Peterson, 2015; Zentall et al., 2012). Music may be one avenue to assist students with ADHD in becoming more focused, successful, and productive in the classroom (Gaastra et al., 2016; Maloy & Peterson, 2015). However, further studies are needed to determine if music can be a useful strategy in the area of improving working memory for students with ADHD. Music has been proven to be a powerful tool which can affect mood, memory, and assessment scores (Bloor, 2009; Cabanac et al., 2013; Kesan, Ozkalkan, Iric, & Kaya, 2012). Pelayo (2014) found that listening to Mozart music elicits feelings from students that promote learning, such as relaxation, happiness, calmness, and the desire to attempt new tasks. However, the results of studies that examine the effects that music has on test scores have mixed results (Kesan et al., 2012). When completing math assessments with and without music present, and with music preference being included as a factor, Kesan et al. (2012) found that scores were higher with preferred music present. Crncec et al. (2006) found that while music and music instruction is important to children, the Mozart effect, an enhancement of performance or change in neurophysiological activity associated with listening to Mozart's music, is difficult to establish in children, and direct instruction in content areas would have more benefit than musical lessons. Studies also suggest that while music may not have a direct impact on cognitive functioning in students with disabilities, it may have a calming effect that could assist students with ADHD in being able to attend more easily to academic content (Crncec et al., 2006; Hallam et al., 2002). While a myriad of research emphasizes the effects of music on the academic success of students with disabilities, empirical research does not emphasize student choice of music. Also, there is limited empirical research regarding how students listening to their choice of music through headphones could affect information retention during study time.

Further, there is no current research on the effects that student-selected music may have on the working memory of students with ADHD. Thus, the correlation between music and cognition requires further research (Cabanac et al., 2013). Current technology allows many students access to their personal music listening devices. Students are often allowed to listen to music of their choice in all setting that sometimes includes the classroom. The opportunity to harness the power of technology and music could be invaluable for students with ADHD. While extensive research has been conducted on the effects of music on the academic success and behavior for students with disabilities (Cabanac et al., 2013; Crncec et al., 2006; Hallam et al., 2002), not enough is known about the effects of self-selected music on the working memory of students with ADHD. While evidence of a relationship between music, mood, academic success, and behaviors have been documented, no relationship has been established between music and the working memory of students with ADHD.

In summary, current research does not indicate whether student-selected music may be able to assist with focus to allow higher retention of information during independent study time of students with ADHD in the classroom., nor does the current literature include any studies that involve students with ADHD choosing their music to determine its effect on working memory. Previous studies use classical music, white noise, and noise reduction headphones, but none have allowed the students to choose their music to determine its effect on working memory. Furthermore, there have been no studies on how music affects working memory of students with ADHD. Current research indicates mixed results regarding the effects of music on the academic success of students (Crncec et al., 2006; Pelayo, 2014; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). A gap in the research exists regarding how self-selected music may impact the working memory of students with ADHD. The literature provides a foundation for music having an impact on student learning; however, exploration is still crucial to determine if self-selected music has an impact on the working memory of students with ADHD.

Purpose Statement

The purpose of this single-subject study is to test the theory of the Mozart effect and the optimal stimulation theory as they relate to student-selected music affecting working memory for fifth students with ADHD and to gain an understanding of how listening to self-selected music affects the working memory of students with ADHD. This study explored the differences in student-selected music, teacher-selected (classical) music, and no music on the working memory of fifth-grade students with ADHD, as well as established a relationship between self-selected music and the working memory of students with ADHD. The working memory of students with ADHD was tested under three conditions: (a) no music, (b) teacher-selected music, and (c) student-selected music. An online working memory test was used to measure the working memory of students with ADHD under each of the conditions, and visual representation of the data was plotted on line graphs for comparison. Other outside distractors such as ringing bells, individuals entering the classroom, individuals moving about the classroom, individuals talking, or other activity that could be distracting to the subjects was eliminated to the greatest extent possible during data collection. Instances of distractions that occurred was documented.

The three conditions that were implemented for this study are self-selected music, teacher-selected music, and no music. Self-selected music is defined as music chosen by the students that was pre-loaded onto the students' personal listening devices. Classical music was used as a comparison to determine if self-selected music has a similar or different impact on working memory than classical music. Classical music is defined as a classical piece that was chosen by the instructor and provided to the students to listen to during working memory testing. For this study, Mozart's sonata for two pianos in D major, K488 was used as the teacher-selected music. This piece was selected as it is the same piece that was used in the original study in which the Mozart effect was coined (Rauscher et al., 1993). The third condition that was presented is no music in a quiet classroom environment that is intended to simulate a typical classroom testing environment. The working memory task was completed with no music present for comparison purposes.

The Significance of the Study

Many children with ADHD have a higher tendency to have difficulties with completing school work, remaining focused in the classroom, and following directions (Cho & Blair, 2017; Curtis et al., 2012; Iseman, 2012). Many also have difficulty with academic achievement, peer relations, executive functioning (working memory), and disruptive behaviors (Curtis et al., 2012; Iseman, 2012). This study is important because the ability to teach students with disabilities to regulate their concentration and behaviors assists with classroom management, learning, and focus. The contribution to the body of knowledge available to teachers of students with disabilities as it relates to strategies that can support academic success also proves valuable. The study also contributes to knowledge regarding music and its effect on academic success. Many studies explore the effects of music on the academic progress for students with and without disabilities (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Rauscher et al., 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). However, there is a dearth of information regarding the direct effect music may have on the working memory of students with disabilities. Current research indicates that there may be a relationship between playing music in the classroom and the ability of students with disabilities to acquire knowledge (Gaastra et al., 2016; Greenop & Kaan, 2007; Imerja, 2013; Maloy & Peterson, 2015).

The majority of students with disabilities are taught within general education classes as mandated by IDEA (2004) and best special education practices (Torreno, 2016). These students must be able to be successful in the general classroom environment in order to graduate and move on to post-secondary pursuits. Students with disabilities must be able to access and manipulate the curriculum in a way that is meaningful for them to be successful. Students with ADHD, in particular, have multiple challenges with attention and focus that create a challenging environment for educators to be able to educate this group of students successfully. Strategies designed to assist students with ADHD are much more effective in the general education setting (Gaastra et al., 2016). Effectively implementing these strategies is important to teachers as well as students with and without disabilities in the general education classroom (Gaastra et al., 2016).

This study hopes to build upon the base of empirical research that supports the theory that music can have a positive effect on memory, behaviors, test taking, and information retention for students with and without disabilities (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Rauscher et al., 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006), which links this research to improving quality of life and learning outcomes, as outlined in the CEC standards of quality (2014). Current research has focused on classical music and types of music that are deemed pleasing by the researchers (Pelayo, 2014; Rauscher et al., 1993). Rauscher et al. (1993) specifically examined the effect of Mozart music, from which the phrase *the Mozart effect* was coined, which demonstrated a connection between music and the ability to learn. However, their study left more questions than answers, thus opening a new opportunity for research.

This study extends the current research by allowing students to choose their music and listen to it through headphones while completing a series of online working memory tasks. Self-selected music has rarely been used in previous studies, and never for measuring working memory in students with ADHD. Pelham et al. (2011) used music as a distractor in a study regarding the effects of an ADHD medication and allowed students to choose their music by voting. After the vote, one musical selection was played in the background for the entire group of subjects (Pelham et al., 2011). Pelham et al. (2011) found that the music that was expected to serve as a distractor did not distract the subjects and, in some cases, help with focus.

Few empirical studies have used self-selected music as a factor. Some studies that used self-selected music asked students to list their favorite songs, and then the researchers played a very limited number of those songs in the room as background music but did not allow the students to completely select their own choices and listen to them with their headphones (Maloy & Peterson, 2015). Liljestrom, Juslin, and Vastfjall (2012) used self-selected music to determine emotional connections to music in college students and found that positive emotions were associated with the music that the students selected. None of the studies that allowed students to select their music focused on students with ADHD or behavior and focus issues. The exploration of allowing students to select their music is a valid concept that requires more studies to understand fully.

In summary, this study adds to the empirical research regarding the effects of music on the working memory of students with ADHD. The ability to teach students with ADHD strategies that can assist with focus during study time assists with classroom management and learning, which can lead to student success in the classroom (Gaastra et al., 2016). Teachers often lack the skills and knowledge to create an environment where students with ADHD can be successful (Gaastra et al., 2016). Teachers are also often frustrated with the lack of academic progress and behaviors for some children with ADHD, and finding innovative ways to strategize for these students is imperative (Gaastra et al., 2016). School-based interventions have proven to be the most effective way to help students with ADHD to succeed (Gaastra et al., 2016). This study increases the understanding of the effects of music on working memory. If students can increase working memory through the use of listening to their own music through headphones, this technique could assist students in their academic endeavors greatly. This study contributes to the body of knowledge available by increasing awareness of available strategies to assist students with disabilities in improving academic success. It also contributes to the empirical research regarding the effects of music on memory and learning.

Research Question

RQ1: Does student-selected music listened to through headphones by fifth-grade students with an ADHD diagnosis increase working memory as measured by online N-back tasks, as compared to no music or teacher-selected classical music?

Hypotheses

$H_0$1: Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to no music.

$H_0$2: Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to teacher-selected classical music.

Definitions

1. *Attention Deficit/Hyperactivity Disorder (ADHD)* – "a chronic neurobehavioral disorder characterized by overactivity and impulsiveness beyond what is considered typical development" (Maloy & Peterson, 2015, p. 328).
2. *Executive Function* – "general-purpose control mechanisms that modulate the operation of various cognitive sub-processes and thereby regulate the dynamics of human cognition" (Miyake et al., 2000, p. 50).
3. *Music Therapy* – "the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program" ("American Music," 2018, para. 1).
4. *Mozart Effect* – "An enhancement of performance or change in neurophysiological activity associated with listening to Mozart's music, . . . described for the first time by Rauscher et al. (1993)" (Verrusio et al., 2015, p. 150).
5. *Percentage of Non-overlapping Data* -- "the proportion of data observed in treatment phases that did not overlap data observed in the baseline phase" (Scruggs & Mastropieri, 2013, p. 11).
6. *Memory* – "a hypothetical cognitive system responsible for providing access to information required for ongoing cognitive process" (Wilhelm et al., 2013, p. 1).

7. *N-back Task* – “participants are presented with a long sequence of stimuli and are requested to decide for each stimulus whether it matches the one *n* steps back in the sequence” (Wilhelm et al., 2013, p. 3).

Summary

Students with ADHD have a difficult time performing well academically, as well as behaviorally (Bussing et al., 2016). This study was based upon the optimal stimulation theory and the Mozart effect theory. Each theory is relevant to this study because the working memory of students with ADHD was measured using an online N-back task under the conditions of self-selected music, teacher-selected (classical) music, and no music present.

Students with ADHD can often be more successful within the classroom with the use of appropriate strategies (Bussing et al., 2016; Cook et al., 2014; Gaastra et al., 2015; Imeraj et al., 2013; Maloy & Peterson, 2015; Zentall et al., 2012). Students with ADHD often have deficiencies in their working memory capacity, and strategies to help increase working memory can assist students with ADHD to be more successful (Coghill et al., 2013; Klingberg et al., 2002; Westerberg & Klingberg, 2007). This study adds to the body of knowledge regarding strategies to assist students with ADHD by examining the effects of self-selected, teacher-selected, and no music on the working memory of students with ADHD.

CHAPTER TWO: LITERATURE REVIEW

Overview

Attention Deficit/Hyperactivity Disorder (ADHD) is defined as "a chronic neurobehavioral disorder characterized by overactivity and impulsiveness beyond what is considered typical development" (Maloy & Peterson, 2015, p. 328). *The Diagnostic and Statistical Manual of Mental Disorders* (2013) describe essential features of ADHD as follows:

> There is developmentally inappropriate inattention, impulsiveness, and hyperactivity beginning before age seven years, appearing at various levels in more than one setting (e.g., home, school, work), and significantly interfering with social, academic, or occupational functioning. In some patients either inattention or hyperactivity-impulsivity predominates, temporarily or indefinitely (p. 137).

Music may be used as a tool for praise, worship, relaxation, celebration, and entertainment. Music has been found to have a positive influence on academic achievement and behaviors for students with and without disabilities (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Rauscher et al., 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). These behavior issues can include being easily distracted and exhibiting off-task behaviors (Busing et al., 2016), as well as exhibiting aggressiveness, self-injurious, and non-compliance behaviors (Desrochers et al., 2014). Additionally, teachers are often ill-equipped to handle the academic needs and behaviors of students with ADHD in the classroom (Lessing & Wulfsohn, 2015). Teachers often lack training and strategies that can help alleviate the academic challenges and behaviors that lead to high-risk factors (Lessing & Wulfsohn, 2015). Music has been found to be an effective classroom strategy for increasing focus and concentration for students with and without disabilities (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Reif, 2016).

Information presented in this chapter examines the needs of students with ADHD, as well as classroom strategies that can assist students with ADHD to become successful in the school setting. This chapter also examines how music affects various aspects of individuals' lives, including physically, emotionally, medically, and academically, as well as the possibility that music can positively affect the academic achievement and behaviors of students with ADHD.

Behavior management is considered to be one of the most important tasks for every teacher when entering the classroom (Koh & Sunwoo, 2014). Problematic behaviors in the classroom are on the rise, and teachers often become quite frustrated due to a lack of skills to handle students with these types of behaviors (Koh & Sunwoo, 2014; Lessing & Wulfsohn, 2015). When learning is taking place in the classroom behavior management issues are reduced (Koh & Sunwoo, 2014). When students with ADHD are unsure of classroom expectations or are given too much freedom within a classroom setting that does not have clearly identified expectations, these students are often easily distracted from the teacher's directives and can become disorderly as well as disrespectful (Marzano, Marzano, & Pickering, 2003). Implementing effective interventions can reduce or eliminate classroom disruptions, which can help increase focus and concentration (Koh & Sunwoo, 2014; Marzano et al., 2003). Children who experience a low ability to maintain attention or who exhibit aggressive behaviors have a much higher risk of low test scores, as both disengagement and aggression can reduce instructional time (Georges, Brooks-Gunn, & Malone, 2012). Some strategies that are effective for students with ADHD include direct instruction on behavioral expectations, as well as frequent feedback, positive reinforcement (including frequent praise), and token economies (Lessing & Wulfsohn, 2015).

Behavior management begins with a systematic plan of rewards and punishments designed to increase desired behaviors as well as decrease unwanted behaviors (Lessing & Wulfsohn, 2015). Effective behavior management plans include a plan to modify the environment to facilitate success, as well as a mechanism to teach students with ADHD to self-regulate their attitudes and behaviors (Lessing & Wulfsohn, 2015). Behavior management is not limited to just academically appropriate behaviors, but also social interactions and attitudes toward others (Lessing & Wulfsohn, 2015). According to Lessing and Wulfsohn (2015), some strategies that are effective for students with ADHD are as follows:

> . . . learners with ADHD be seated away from potentially distracting areas, not using cluster seating, learners be seated in the front row to enable the teacher to best observe and monitor behaviour, using a buddy system, peer tutoring, to give instructions for only one task at a time and more difficult work should be dealt with earlier rather than later in the day (p. 59).

Teachers who are trained to apply effective behavior management strategies and follow through with these strategies with fidelity can significantly reduce unwanted behaviors in the classroom (Lessing & Wulfsohn, 2015).

For students with disabilities, behavior management is an increasingly challenging topic (Desrochers et al., 2014; Lessing & Wulfsohn, 2015). The difficulties that these students experience affect them both academically and socially, and the implications are far reaching into their futures (Busing et al., 2016; Lessing & Wulfsohn, 2015). Students with ADHD diagnoses have a great difficulty attending to school work and behaving appropriately in the classroom

(Busing et al., 2016). They are at a high risk of exhibiting behaviors that become barriers to their success in the classroom, and these behaviors put them at a much higher risk for academic failure (Cho & Blair, 2017). Students with disabilities often exhibit inappropriate classroom behaviors, including aggressive behaviors, self-injurious behaviors, and noncompliance behaviors, in addition to learning and processing problems (Desrochers et al, 2014). Behaviors such as these can lead to academic deficits; however, it is important to note that students with ADHD also have a higher likelihood of a comorbid disability, such as specific learning disability in the areas of math and reading, than their non-disabled peers (Zentall et al., 2012). Students with disabilities, including those with ADHD, are much more likely to exhibit inappropriate classroom behaviors than normally developing peers (Bussing et al., 2016; Cho & Blair, 2017; Cook et al., 2014; Curtis et al., 2012; Gaastra et al., 2016; Lessing & Wulfsohn, 2015). Finding new and innovative ways to help students with disabilities to control behavior issues in the classroom may be more critical for teachers and students than academic teaching skills (Koh & Sunwoo, 2014). Teachers must have the knowledge and skills to implement effective strategies to support students with ADHD so that all students within the classroom can succeed (Lessing & Wulfsohn, 2015). It is imperative that teachers have the tools and training they need to be able to reach this special population so that they can be successful in the classroom (Lessing & Wulfsohn, 2015). However, tools and training are useless unless the key stakeholders (teachers, students, and parents) are interested in the tools and willing to implement best practices with students (Bussing et al., 2016).

Music is an important aspect of the lives of children at every stage of development and into adulthood for their “social-emotional and intellectual-artistic domains” (Campbell, Connell, & Beegle, 2007, p. 221). By the time children reach their adolescent years, they are fully engaged in music, embraced it as a large part of their lives, and even become significant consumers of it (Campbell et al., 2007; Hallam et al. 2002). Teenagers listen to music as much as three hours per day in order to help them establish their identities as well as regulate their emotions (Hallam et al., 2002). Music becomes part of their identity as they begin to separate themselves as individuals and mature into adults (Campbell et al., 2007). Finding ways to incorporate popular music into the classroom could provide a way to connect with children, making their experiences in the educational setting more simulating and pleasing (Campbell et al., 2007). In contrast to popular music, one type of music that has been shown to improve classroom behaviors and academic achievement is classical music (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Rauscher et al., 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006).

Classical music can be used as a strategy to assist with behaviors and academic achievement in the classroom (Cabanac et al., 2013; Dosseville et al., 2012; Pelayo, 2014; Rauscher et al., 1993; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). Listening to classical music can have an emotional effect on people, helping them to become more relaxed and focused (Pelayo, 2014). Classical music played during math assessments can also lead to higher test scores (Cabanac et al., 2013; Taylor & Rowe, 2012). It can also have a positive effect on memory (Dosseville et al., 2012; Verussio et al., 2015). Listening to classical music may also have a positive effect on numerous medical conditions (Attanasio et al., 2012; Lung-Chang et al., 2012; Verussio et al., 2015; Ziv, Granot, Hai, Dassa, & Haimov, 2007). In addition to classical music, numerous studies indicate that self-selected music may benefit students in the areas of academic achievement (Zentall et al., 2012), mood (Campbell & White, 2015; Labbe, Schmidt, Babin, & Pharr, 2007; McFerran et al., 2015), and anxiety (O’Callaghan et al., 2012; Padam et al., 2017). However, further research is needed to determine whether self-selected music can affect the working memory of fifth-grade students with an ADHD diagnosis.

Chapter Organization

An exhaustive review was conducted using the following keywords: Attention Deficit/Hyperactivity Disorder (ADHD), music, background music, behavior management, strategies, students, and classroom. The literature centered around the following topics: music and students with ADHD, background music, music's effect on math and reading achievement, music instruction, student-selected music. The review begins with a review of how background music affects individuals with and without disabilities in the educational setting, medical setting, and during physical activity. Next, the literature selected indicates how music has an effect on subject areas, including literacy and math achievement. Next, music’s effect on mood, emotions, and anxiety was examined, as well as the impact of student-selected music on the academic achievement and mood of individuals. The topic of how student-selected music can affect students with ADHD is addressed within this literature review. Music’s impact on students with ADHD is also examined, including music therapy and background music, followed by a discussion of ADHD and working memory.

Theoretical Framework

In order to assist with the understanding of the interaction of music and behaviors, it is important to examine theories that relate to the current study. Two theories are discussed in this section as they relate to the current study: the optimal stimulation theory (Hebb, 1955; Schlosberg, 1954) and the Mozart effect theory (Rauscher et al., 1993). The first theory, optimal stimulation theory states that too little stimulation can cause boredom and disinterest, while too much stimulation may be overwhelming (Hebb, 1955; Schlosberg, 1954). The second theory used to support the current study is based upon is the Mozart effect (Rauscher et al., 1993).

Optimal Stimulation Theory

The optimal stimulation theory was originated in the 1950s by D. O. Hebb with McGill University and Harold Schlosberg with Brown University, who stated that with too little stimulation individuals can become bored and disengaged; furthermore, too much stimulation becomes quickly overwhelming (Hebb 1955; Schlosberg, 1954). In later years, the theory was specifically applied to children with ADHD as well as normally developing individuals (Antrop, Buysse, Roeyers, & Oost, 2005; Baijot et al., 2016; Gordon & Gridley, 2013; Guang-Xin & Lee, 2008; Kercood & Banda, 2012; Zental & Kruczek, 1988). The optimal stimulation theory is supported through empirical studies that include the use of color, wait time, and enjoyment. This theory has been applied to visual stimulation through color in which researchers measured the success of a task with color added to letters as compared to the same task with black print only (Zentall & Kruczek, 1988). Zentall and Kruczek (1988) found that students with attention problems performed better with the presence of color in the activity. The reaction to wait time in children with and without ADHD also added credence to the optimal stimulation theory (Antrop et al., 2005). Antrop et al. (2005) required students with and without an ADHD diagnosis to wait with no stimulation, with a story being read, and with a constant noise added to determine if the students were able to remain still as well as behave during the three conditions. Antrop et al. (2005) found that students with ADHD were able to remain still and behave better when they waited with a story presented. The optimal stimulation theory has also been tested in the area of enjoyment levels, anticipated enjoyment of movies (Guang-Xin & Lee, 2008), and learning to play a musical instrument (Gordon & Gridley, 2013).

More recently, the optimal stimulation theory was tested in regards to the effects of white noise on students with and without an ADHD diagnosis (Baijot et al., 2016), as well as the addition of physical activity to focus (Kercood & Banda (2012). Baijot et al. (2016) conducted a study with students ages seven to 12 (*N*=30) and found that students with ADHD diagnoses were able to improve focus in the presence of white noise. Kercood and Banda (2012) conducted a single-subject alternating treatment design study with students ages 10 to 12 years old (*N*=4), three of whom had attention/learning difficulties and one who was typically developing. Kercood and Banda (2012) added two types of physical activity to a learning activity to determine if focus could be improved and found that students improved performance as well as accuracy with the addition of physical activity. The optimal stimulation theory can apply to the current study because stimulation is being added to a working memory activity for students with ADHD to determine if the extra stimulation might be helpful in increasing working memory scores. This study attempts to determine whether added stimulation (student-selected music or classical music) affects the working memory of students with ADHD.

The Mozart Effect Theory

The Mozart effect is a theory that was developed through research completed by Rauscher et al. (1993). While Rauscher et al. (1993) did not coin the phrase, their research on the effects of Mozart music on the Intelligence Quotient (IQ) for spatial reasoning tasks caught the attention of many. Rauscher et al. (1993) found that participants who received the condition of Mozart music during testing had IQ scores eight to nine points above participants who did not receive the condition of Mozart music (no effect size noted). This study was limited to a small number of participants (*N*=36), and only one Mozart selection was used (Rauscher et al., 1993). Nevertheless, *The Mozart effect* was coined, and several researchers have attempted to prove or disprove the theory since that time (Crncec et al., 2006; Pelayo, 2014; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). The Mozart effect gained a great deal of popularity through media shortly after the original study completed by Rauscher et al. (1993). However, numerous studies have both confirmed the Mozart effect, as well as yielded insignificant and unreliable results (Crncec2006; McKelvie & Low, 2002; Pelayo, 2014; Taylor & Rowe, 2012; Verrusio et al., 2015; Waterhouse, 2006). Due to these conflicting findings, researchers have recommended caution.

Waterhouse (2006) critically examined the Mozart effect and concluded that while the music may stimulate emotions that could affect spatial relations, caution should be used before applying the theory in an academic setting. Rauscher and Hinton (2006) agreed that caution should be applied while noting the differences between music listening and music instruction. Rauscher further led several research projects after the original 1993 project. These projects included research regarding the effects of music listening, as well as music instruction, on learning behaviors and concluded that there is exceeding evidence to support music instruction as a valuable tool for improved spatial reasoning over listening to music alone (Rauscher & Zupan, 2000; Rauscher et al., 1997; Rauscher, 2002; Rauscher, 2003; Rauscher & Hinton, 2006; Rauscher & Hinton, 2011).

The Mozart effect theory (Rauscher et al., 1993) supports this study's hypothesis because the independent variable of student-selected music could influence or explain the dependent variable (working memory of students with ADHD). Variance in the working memory scores of students with ADHD could be attributed to the presence or absence of student-selected music based on the Mozart effect theory (Rauscher et al., 1993). The purpose of this study is to test the theory that music has an impact on the working memory of fifth-grade students with ADHD.

Related Literature

Music's impact on the academic performance, mood, anxiety level, and medical conditions of individuals of various age groups, with and without disabilities, is a widely researched body of knowledge (Cabanac et al., 2013; Pelayo, 2014; Taylor & Rowe, 2012; Verussio et al., 2015). Background music has been used in educational, medical, and exercise settings for individuals with and without disabilities (Bloor, 2009; Crncec et al., 2006; Digelidis, Karageorghis, Papapavlou, & Papaioannou, 2014; Patson & Tippett, 2011; Tze & Chou, 2010; Waugh & Riddock, 2007; Ziv & Doley, 2013). Music has been found to affect academic scores, including math achievement (An & Tillman, 2015), and has a calming effect on mood as well as anxiety (Nguyen & Grahn, 2017; Southgate & Roscigno, 2009). The study of music outside of academic settings can also have an impact on academic ability (Hallam et al., 2002; Hetland, 2000). The following literature review outlines the empirical knowledge available in the area of music.

Background Music

For this study, background music is defined as music playing within a room loud enough for individuals in the room to be able to hear the music, but soft enough that students can hear instruction. The music is played aloud for everyone in the room to hear without the use of headphones. The effects of background music on the behaviors and academic success of students with a wide range of disabilities, as well as their non-disabled peers, has been extensive (Bloor, 2009; Crncec et al., 2006; Digelidis et al., 2014; Patson & Tippett, 2011; Waugh & Riddock, 2007; Tze & Chou, 2010; Ziv & Doley, 2013). A myriad of benefits to playing music in an academic setting have been identified (Desrochers et al., 2014; Jausovec, Jausovec, & Gerlic, 2006; Verrusio et al., 2015; Ziv & Doley, 2013). The effects of background music on the mood and emotional arousal of individuals may affect memory as well as cognitive performance (Nguyen & Grahn, 2017). Background music in the educational setting can help increase academic performance and memory, as well as help reduce distracting behaviors (Desrochers et al., 2014; Jausovec et al., 2006; Yen-Ning et al., 2016). Background music has also been found to decrease symptoms in patients with Alzheimer's, schizophrenia, and depression (Ansari, Negahban, & Sayyadi, 2011; Zincir et al., 2011; Ziv et al., 2007), as well as decrease anxiety related to medical and dental procedures (Padam et al., 2017; Pintea et al., 2017).

Background music in educational settings. Music played in the background of an educational setting can help reduce or even prevent behaviors that are barriers to academic success (Desrochers et al., 2014). Several of these barriers include bullying, unwanted distracting behaviors, anxiety, and reading difficulties (Desrochers et al., 2014; Yen-Ning et al., 2016; Ziv & Doley, 2013). First, background music has been found to reduce bullying behaviors in some children (Ziv & Dolev, 2013). Ziv and Dolev (2013) conducted a study with 11 to 12-year-olds without disabilities (N=32) and found that bullying behaviors decreased during recess when background music was played. The effect size was noted as significant ($p < .005$). Ziv and Doley (2013) attributed the reduction in bullying behaviors to a more positive atmosphere created by background music playing. In addition to reducing bullying behaviors, background music in the educational setting may also reduce unwanted and distracting behaviors for students with disabilities in the academic setting (Desrochers et al., 2014). Desrochers et al. (2014) conducted a single-subject design study with one 13-year-old girl who had multiple disabilities and blindness. While music played in the background, unwanted behaviors (standing up, selfstimulating such as rocking) decreased and wanted behaviors (head up) increased while music played in the background. Research has shown music can be used in the classroom for students with ADHD to help them focus and block out other distractions (Chew, 2010; Reif, 2016). Music has a calming effect for some school-aged students with behavior problems, including those with ADHD, and this calming effect may help these students to focus on academic topics (Chew, 2010; Crncec et al., 2006; Hallam & Price, 1998). Music played in the background of educational settings that is perceived as calming by children with emotional and behavioral disorders may be able to decrease unwanted behaviors as well as increase academic achievement (Hallam & Price, 1998). Hallam and Price (1998) conducted a study with students ages 9 to 10 years old (*N*=10) who have emotional and behavioral issues that negatively affected their ability to achieve academically. When music the children perceived as calming was played during a math assessment, the children with emotional and behavioral disorders were able to complete a higher number of math problems correctly, and they exhibited significantly fewer instances of rule-breaking behavior during the math assessment (Hallam & Price, 1998). Music can calm students with ADHD after an overly stimulating activity such as recess or gym class, as well as assist with smoother transitions between activities (Digelidis et al., 2014; Reif, 2016). Digelidis et al. (2014) conducted a counterbalanced mixed-model design study with high school seniors (*N*=200) in which satisfaction and motivation of students during gym class was compared with music (student-selected as well as teacher-selected) and no music present. The students reported significantly higher satisfaction and motivation while participating in gym class with music playing in the background regardless of whether the teacher chose the music or the students chose the music (Digelidis et al., 2014). The experience for these students may be increasingly pleasant in the presence of music based on a resolution of cognitive dissonance, which is a conflict between two cognitions which can cause discomfort and stress (Perlovsky et al., 2013). Perlovsky et al. (2013) conducted a study with 14 to 15-year-old normally developing high school students (*N*=64) in which music perceived as pleasant and music perceived as unpleasant were played in the background of an academic assessment, and scores of the assessments were compared. Perlovsky et al. (2013) found that assessment scores were higher among the participants who perceived the background music playing to be pleasant, thus concluding that cognitive dissonance and stress can be alleviated through the soothing use of music playing during stressful experiences such as assessments.

Medical effects of background music on mental health patients. The medical field has also shown some implications of background music affecting the mood of patients with a diagnosis of Alzheimer's, schizophrenia, and depression (Ansari et al., 2011; Zincir et al., 2011; Ziv et al., 2007). Alzheimer's is a common form of dementia that can cause difficulty with memory, personality changes, and other areas of mental functioning (Ziv et al., 2007). Ziv et al. (2007) conducted a study with Alzheimer's patients (*N*=28) that indicated that positive behaviors increased and negative behaviors decreased when popular music from 1964, which was familiar to the participants, was played in the background. Ziv et al. (2007) found that when patients with Alzheimer's listened to music, the effects of the disorder were lessened. Patients with schizophrenia also showed improvement in general functioning and social relationships when presented with music therapy treatment (Zincir et al., 2011). When exposed to music therapy in the form of classical Turkish musical tones over a period of 12 sessions, schizophrenia patients were able to decrease antisocial behaviors and increase their ability to adapt in social situations (Zincir et al., 2011).

Depression is another common disorder that can be quite debilitating for individuals (Ansari et al., 2011). Ansari et al. (2011) found that music therapy, particularly the rhythmic sound of reciting the Koran, has a positive treatment effect on patients diagnosed with depression. Ansari et al. (2011) conducted a study in which participants who had been diagnosed with depression (*N*=60) were randomly placed in two groups, one of which listened to the Koran being recited in seven, 15-minute sessions over the course of two weeks. Individuals diagnosed with depression showed improvement, and those patients who believed in the Koran's message showed a higher level of improvement (Ansari et al., 2011).

Background music and anxiety related to medical procedures. Anxiety is often related to having medical and dental procedures (Padam et al., 2017; Pintea et al., 2017). This type of anxiety may be reduced through the therapeutic use of music (Padam et al., 2017). In a similar setting, Padam et al. (2017) determined that "Vedic chants and Indian classical instrumental music" may have a positive effect on the reduction of anxiety as it is related to undergoing a surgical procedure (p. 214). This may be due to a reduction in anxiety levels (Padam et al., 2017). Sardari and Mashizi (2016) measured patients' Cortisol level, which is a hormone that is released as anxiety increased. The researchers found that when dental patients underwent a procedure with patient-selected music playing in the background during the dental procedure, Cortisol levels decreased throughout the procedure, which indicates that anxiety levels were reduced as compared to those dental patients who did not have music playing in the background during the procedure (Sardari & Mashizi, 2016). However, Pintea et al. (2017) conducted a study comparing the anxiety as well as pain levels of dental patients (*N*=123) under the conditions of no music, symphonic music, as well as lounge music playing in the background, and found that no significant change in the perceived pain level or anxiety level of the dental patients was found as measured via Likert scales and participants' pulse rates. A similar result was found with patients who received the condition of either symphonic music or lounge music did not experience a decrease in anxiety or perceived pain levels as compared to the control group with no music playing (Pintea et al., 2017). Pintea et al. (2017) found that the only effective reduction in anxiety and pain perception was ending the dental procedure. However, Pintea et al. (2017) did not utilize the condition of patient-selected music.

Patient-selected music may have a positive effect on radiotherapy treatment experiences (O'Callaghan et al., 2012). O'Callaghan et al. (2012) conducted a study with adult patients (N=100) to determine if self-selected music could reduce anxiety related to initial radiotherapy treatment. While anxiety levels were not affected, the patients enjoyed the music and wanted the music to be available for future treatments (O'Callaghan et al., 2012). Although no significant findings were noted for anxiety, the patients reported feeling distracted from their procedure, as well as time passing more quickly while listening to the music (O'Callaghan et al., 2012).

Background music during physical activity. Research shows that background music has been found to be useful in the areas of physical activity and gym classes (Digelidis et al., 2014; North, Tarrant, & Hargreaves, 2004). Music played during gym class or gym activities has a positive effect on the general perception of the activity and motivation (Campbell & White 2015; Digelidis et al., 2014; North et al., 2004). North et al. (2004) conducted a study with adult gym members (N=646) in which uplifting music was played in the background of a gym while individuals were exercising. Individuals who listened to the uplifting music during exercise were more likely to offer assistance to others (North et al., 2004). This theory was strengthened by Digelidis et al. (2014) who found that students who listen to music during their physical education classes had more motivation and appreciation of the physical activities. Furthermore, Campbell and White (2015) found that individuals who listen to self-selected music during exercise felt better with less fatigue after exercise as compared to those individuals who exercised with no music. Individuals who exercise with self-selected music as compared to those with no music during exercise self-reported higher levels of enjoyment of the activity (Campbell & White, 2015). Music played during physical activities can affect the participant's perception of the activity, motivation to participate, and mood (Campbell & White 2015; Digelidis et al., 2014; North et al., 2004). Heart rates and breathing rates are also affected by the tempo of music (Bernardi, Porta, & Sleight, 2006).

Background music for students with disabilities. Background music has been found to affect students with disabilities (Desrochers et al., 2014; Lundqvist, Anderson, & Viding, 2009; McFerrin, Thompson, & Bolger, 2016). Music played in the background of academic settings for students with emotional, behavioral, and learning disabilities can have a calming effect and assist with focus on academic skills (Crncec et al., 2006; Hallam et al., 2002). McFerrin et al. (2016) stated that, "rather than seeing music as a tool that supports the acquisition of specific skills, the professionals and students in the school came to understand that music could be a meaningful part of their encounter with one another" (p. 241). Music can create a context in which children have interests and activities in common with others when they might not otherwise be exposed to such activities (McFerrin et al., 2016). Desrochers et al. (2014) conducted a single-subject study and found that a 13-year old girl with blindness as well as severe-profound intellectual disability (N=1) was able to pointedly reduce her incidence of standing up, self-stimulatory behavior, and increase the desired behavior of head up through music being played in the background. Other types of music may also affect the behaviors of students with disabilities.

Vibroacoustic music is music that allows the students to hear and "feel" the music at the same time, which may have a soothing effect that can help them control their behaviors more easily (Lundqvist et al., 2009). Vibroacoustic music, music therapy that involves vibration, can also serve as an effective treatment for students with autism who have a high risk for "self-injurious behavior (SIB), stereotypical behavior (SB) and aggressive destructive behavior (ADB)" (Lundqvist et al., 2009, p. 392). Lundqvist et al. (2009) conducted a study with adult participants ages 22 to 57 with autism (N=20) who were exposed to vibroacoustic music in 10 to 15-minute increments over five weeks. The participants showed significant improvements in unwanted behaviors associated with Autism Spectrum Disorder (Lundqvist et al., 2009). Additional research suggests that having children listen to calming music for a specific period of time each day can help reduce these types of behaviors in children with visual impairment which helps them to access education (Villasenor & Vargas-Colon, 2012). Villasenor and Vargas-Colon (2012) conducted a single-subject design study with a 13-year-old female and 16-year-old male (N=2) both with visual impairment. The students listened to 15 minutes of calming sounds per day during the morning each school day (Villasenor & Vargas-Colon, 2012). Both students experienced an increase in desired behaviors such as participation level, memory skills, and tolerance level of noises in the room (Villasenor & Vargas-Colon, 2012). In addition to students with blindness, music may positively affect students with severe intellectual disabilities (Waugh & Riddock, 2007). Waugh and Riddock (2007) conducted a study with primary students with intellectual disabilities (N=24) in which the painting quality and level of deviant behaviors were measured by created Guttman scales over a period of six weeks. Waugh and Riddock (2007) found that students with severe intellectual disabilities were able to significantly improve their behaviors and painting skills when classical music was played in the background during painting instruction.

Background music summary. The effects of background music on students with and without disabilities are supported in the literature. Background music has been shown to improve the mood of students and adults (Digelidis et al., 2014; North et al., 2004; Ziv et al., 2007). Playing background music in an academic setting can have positive effects on learning and test scores (Bloor, 2009). However, it may be more of a distractor for some students (Bloor, 2009; Patson & Tippett, 2011; Tze & Chou, 2010).

Music's Effect on Subject Areas

Music can affect achievement in math, reading, and other subject areas. It can be integrated directly into the academic lessons through song, movement, and discussion (An, Capraro, & Tillman, 2013; An & Tillman, 2015; Harris, 2008; Walton, 2014). Music can also be directly taught separately from curriculum (Cabanac et al., 2013; Patson & Tippett, 2011; Rauscher, 2001; Rauscher, 2002; Rauscher et al., 1997; Rauscher & Zupan, 2000; Yim-Chi, Mei-Chun, & Chan, 2003), and music can also be played in the background during academic lessons (Jausovec et al., 2006; Nguyen & Grahn, 2017; Verrusio et al., 2015). Music may be self-selected (An & Tillman, 2015; Bloor, 2009; Hallam & Price, 1998; Perham & Currie, 2014; Zentall et al., 2012) or teacher-selected (Jausovec et al., 2006; Tze & Chou, 2010; Yen-Ning et al., 2016). Often, classical music or other soothing music is chosen to be played as background music (Jausovec et al., 2006; Tze & Chou, 2010; Yen-Ning et al., 2016).

The focus of this section is on the effects of music on the academic subjects of math and reading as it relates to background music, integrated music lessons, and music instruction. An extensive search of ERIC, Academic Search Complete, and Education Research Complete databases with the keywords “science, social studies, history, music, background music, integrated music, instruction, and achievement” was completed. A Pro Quest search was also completed using the keywords, “music, social studies, and science” with no relevant studies located. No recent empirical studies that involved other academic subjects outside of math and literacy were found. Fewer empirical studies were found in the area of literacy than in math. However, those studies found in literacy were included in this literature review. When the search was expanded to those older than five years, two older studies that discussed the effects of music on social studies were located (Hailat et al., 2008; Kinney, 2008). Hailat et al. (2008) conducted a study in which information retention of seventh-grade Jordanian students (*N*=258) with no disabilities noted during social studies lessons with music played in the background was compared to information retention of students who received the same lessons with no music playing. Students who received the condition of music playing in the background during social studies instruction outperformed those students with no music playing in the background (Hailat et al., 2008). The second study compared the achievement scores of sixth and eighth-grade middle school students (*N*=882) who participated in music instruction outside of their regular curriculum with those who did not (Kinney, 2008). The sixth-grade students who participated in music instruction performed better in all areas of the achievement test, including social studies (Kinney, 2008). However, the eighth-grade students who participated in music instruction performed better in all areas of achievement except social studies (Kinney, 2008). The area of music’s effect on subject areas other than math and reading requires much further study as there is a dearth of empirical data in this area.

Background music. Research indicates that there are conflicting results in the area of background music and academic success. Music played in the background during academic assessments has been found to increase test scores in some subjects (Bloor, 2009). However, studies have also shown that background music can be more of a distraction in some situations (Bloor, 2009; Patson & Tippett, 2011; Tze & Chou, 2010). Background music may have an effect on the brain that can help with retention of information learned (Verrusio et al., 2015). Brainwave activity that is linked to memory may increase while listening to music playing in the background (Verrusio et al., 2015). Playing music in the background of academic tasks can also have a positive effect on memory and task performance (Jausovec et al., 2006). Jausovec et al. (2006) determined that Mozart music specifically has a significant impact on memory and task performance. Nguyen and Grahn (2017) conducted a study in which low arousal and high arousal music were played during learning and testing experiences with college students (*N*=30) to determine the effect of various types of background music on memory. In order to measure memory, participants used a computer program that showed them a list of words during a study session and then asked to recall as many as possible during a testing session. Nguyen and Grahn (2017) found that low arousal background music provides a contextual cue to recall information that was learned while the music was playing. However, when high arousal music was played during learning experiences, no effect on memory was noted (Nguyen & Grahn, 2017).

Background music and literacy. Mozart played in the background of educational settings may help reduce anxiety and increase reading comprehension for elementary students (Yen-Ning et al., 2016). Yen-Ning et al. (2016) conducted a study in which Mozart music was played in the background during reading instruction for normally developing elementary aged students (*N*=66). Reading texts and comprehension tests were used to determine reading fluency and comprehension scores (Yen-Ning et al., 2016). Participants reported that listening to the Mozart music helped them to relax and feel less anxiety towards learning, as well as improve reading rates and comprehension (Yen-Ning et al., 2016).

Background music played during reading activities may also be more of a distractor than a benefit for normally developing individuals (Tze & Chou, 2010). Tze and Chou (2010) conducted a study with college students with no noted disabilities (*N*=33) to compare reading comprehension data under the conditions of classical music playing in the background, hip-hop music playing in the background, and a quiet room. While the participants indicated that they experienced a higher level of distraction from hip-hop music than classical music, the researchers concluded that the best atmosphere for reading comprehension is a quiet room (Tze & Chou, 2010). Further, Bloor (2009) conducted a study with primary age, normally developing children that involved background music playing during math and reading assessments. The children were provided with the same instruction in math and English and were tested with music as well as without music playing in the background (Bloor, 2009). The results supported that music is helpful in the area of reading but not math (Bloor, 2009). The research findings regarding the effects of background music and assessment scores vary widely.

Background music and math. The connection between music and math has been made for centuries, back to the time of Pythagoras and before who cited the relationship between math and music (Southgate & Roscigno, 2009). While there are mixed results in studies regarding the effectiveness of background music in academic settings, research indicates that the effect of background music on mathematic ability may be less ambiguous (An & Tillman, 2015; Hallam & Price, 1998; Kesan et al., 2012; Taylor & Rowe, 2012; Zentall et al., 2012). In a review of empirical studies regarding the relationship between music and academic achievement. Southgate and Roscigno (2009) concluded that an association exists between music participation and academic achievement, especially in the area of math. Background music played while students perform mathematical tasks has been shown to have a positive impact on the mathematic ability of some students (An & Tillman, 2015; Hallam & Price, 1998; Kesan et al., 2012; Taylor & Rowe, 2012; Zentall et al., 2012).

Cranmore and Tunks (2015) surveyed 24 high school students to obtain their perception of the connection between math and music. The majority of the participants in this study felt that there was a strong connection between math and music (Cranmore & Tunks, 2015). Hsieh and Kuo (2016) conducted a study regarding the characteristics of individuals who are talented in the area of mathematics. They found that the majority of the mathematically talented individuals also had musical backgrounds (Hsieh & Kuo, 2016). Because of the importance of spatial reasoning for everyday activities, including math achievement, Hetland (2000) conducted a meta-analysis of 15 studies regarding music instruction and performance on spatial tasks and concluded that "active music instruction lasting two years or less leads to dramatic improvements in performance on spatial-temporal measures" (Hetland, 2000, p. 203).

Several empirical studies have shown a connection between background music and math (Hallam & Price, 1998; Hallam et al., 2002; Hetland, 2000). Hallam and Price (1998) conducted a study with students ages 9 to 10 years old (N=10) who attended a school for students with behavioral and emotional issues, in which background music was played during math assessments. While the effect on the students' behaviors was not statistically significant, the number of correctly completed math problems increased significantly with music in the background during the assessment (Hallam & Price, 1998). Hallam et al. (2002) conducted a review of two studies that examined the effects of background music on math achievement and memory. "The calming music led to better performance on both tasks when compared with a no-music condition" (Hallam et al., 2002, p. 111). Taylor and Rowe (2012) conducted a study with college students (*N*=128) enrolled in a trigonometry class with no disabilities noted. Taylor and Rowe (2012) found that student achievement on math assessments significantly increased with Mozart music playing in the background during trigonometry assessments. However, music may be a distracting factor for some during math assessments (Bloor, 2009). Bloor (2009) found that, "Whilst this thesis was not proven, it is suggested that the music may have supported the reading tests but conversely disrupted the mathematics tests" (p. 261).

Self-selected music and subject areas. The type of music played had a significant impact on the results of the studies, as music perceived as unpleasant does not have the same effect as music that is perceived as calming, thus supporting the fact that the impact background music has on achievement and memory is more related to mood than cognitive processes (Hallam et al., 2002). Chew (2010) conducted a study on students with ADHD diagnosis ages 9 to 15 (*N*=12) regarding the effects of different types of background noises (silence, classical music, pop music, and a television program). Students were able to sustain attention and enjoyed the activity more with the popular music playing in the background than with silence, classical, or a television program playing in the background (Chew, 2010). Therefore, students with ADHD were able to increase their scores on an academic task when popular music that they enjoyed played in the background (Chew, 2010).

Student-selected music and literacy. In an extensive review of the literature using the keywords "reading, literacy, self-selected, and music," only one study was located that pertained to student-selected music and literacy. Perham and Currie (2014) conducted a study in which undergraduate students ages ranging from 19 to 65 with no noted disabilities (*N*=30) participated in reading assessments under the conditions of no music, student preferred music, music disliked by the students, and classical music. Perham and Currie (2014) concluded that music playing in the background, whether it be preferred or non-preferred, was disruptive for the students during the reading comprehension assessments.

Student-selected music and math. Student-selected music may have an impact on math achievement for students with and without disabilities (An & Tillman, 2015; Hallam & Price, 1998; Zentall et al., 2012). Bloor's (2009) study contradicts several studies that indicate that musical stimulus may have a positive effect on academic abilities for general education elementary students in the area of math (An & Tillman, 2015), as well as elementary age students with emotional and behavioral disabilities (Hallam & Price, 1998; Zentall et al., 2012). Background music may also have a positive effect on math scores for college-age students (Taylor & Rowe, 2012), but the effect may be higher when students can choose the music that is played (Kesan et al., 2012). Students with emotional and behavioral concerns can also experience benefit in the area of math achievement from music that is perceived as mood calming playing in the background (Hallam & Price, 1998). However, students may perform better on math assessments while listening to self-selected music (Greenop & Kann, 2007; Zentall et al., 2012). In a review of the literature on students with ADHD, Zentall et al. (2012) found that boys with ADHD who were allowed to select their music during a math assessment completed more math problems correctly under that condition as compared to talking in the background and silence in the background. Greenop and Kann (2007) conducted a study with students (N=42) who had an ADHD diagnosis (n=22) and those who did not have an ADHD diagnosis (n=20) to determine the effect of student-selected music during a math assessment for both students with ADHD and without an ADHD diagnosis. Both groups benefited equally from the background music and experienced increased performance with the presence of self-selected background music during a math assessment (Greenop & Kann, 2007). Further, student-selected music playing in the background of math assessments may have a higher level of impact on math achievement (Kesan et al., 2012). Kesan et al. (2012) conducted a study in which freshman students with no disability noted (*N*=98) were able to indicate their preference of types of music and found that when self-selected music was playing in the background during a math assessment, the number of correctly completed problems increased significantly, except for those students whose musical preference was Mozart, in which case the scores decreased. Students with ADHD, who often require a higher level of stimulation than their non-disabled peers to assist with focus, can benefit from self-selected music playing in the background during math assessments (Zentall et al., 2012).

Music integrated subject areas lessons. Music integrated lessons include song, movement, and rhythm in content area lessons (An, Capraro, & Tillman, 2013; An & Tillman, 2015; Harris, 2008; Walton, 2014). The music is not a separate lesson, but rather it is a part of the instruction (An, Capraro, & Tillman, 2013; An & Tillman, 2015; Harris, 2008; Walton, 2014). Music integrated lessons can be useful for literacy (Walton, 2014) and math (An, Capraro, & Tillman, 2013; An & Tillman, 2015; Harris, 2008)

***Music integrated literacy lessons*.** An extensive search of empirical research using the keywords, "music, integrated, integrated lessons, literacy, and reading," only located one empirical study in this area. Adding song and movement to literacy instruction can have a significant impact on learning to read (Walton, 2014). Walton (2014) conducted a study in which the reading skills of kindergarten students (*N*=101) who received music integrated reading instruction were compared to kindergarten students who received the same amount of regular reading instruction. The students who received music integrated lessons experienced significantly higher gains in the area of reading as compared to those students who received regular reading instruction (Walton, 2014).

***Music intergraded math lessons*.** Empirical research has shown classrooms with music-mathematics integrated lessons can achieve significantly higher math scores than those students who receive math instruction alone (An, Capraro, & Tillman, 2013; An & Tillman, 2015; Harris, 2008). Music and math integration are achieved through composition, performance, listening activities, and discussion questions related to their math curriculum (An et al., 2013; An & Tillman, 2015). Harris (2008) conducted a study with three to five-year-old typically developing students (*N*=190) to compare the academic progress in the area of math of the students who received instruction with music integrated into the curriculum as compared to instruction with no music integrated. On a mathematics post-test, the children who experienced the musically integrated instruction outperformed those students who received traditional instruction without the integrated music (Harris, 2008). An and Tillman (2015) conducted a pretest-posttest control group design study with third grade students between the ages of seven and eight with no noted disabilities (*N*=56) in which students were placed into two groups, one receiving music-math integrated lessons and the other receiving math lessons without music (An & Tillman, 2015). An and Tillman (2015) found that the students who received the music-mathematics integrated lessons had statistically significant improvements between the pre-and posttest results, while the students who received math lessons without musical integration did not.

Music instructions effect on subject areas. Music integration differs from music instruction in that music instruction is received outside of the regular academic setting while music integration is provided during academic instruction. Music instruction is considered music classes outside of academic coursework, and it may have an impact on students' abilities to retain information (Cabanac et al., 2013; Patson & Tippett, 2011; Rauscher, 2001; Rauscher, 2002; Rauscher et al., 1997; Rauscher & Zupan, 2000; Yim-Chi et al., 2003). However, this is a controversial topic, as it is unclear as to whether students who receive music instruction increase their ability to achieve academically or if students who are interested in music instruction already have a propensity to higher achievement (Cabanac et al., 2013; Dege et al., 2011; Patson & Tippett, 2011; Pelayo, 2014; Schellenberg, 2004). Shin (2011) surveyed low-income students and parents regarding their perception of their ability to perform academically after participating in a music instruction program. Both groups reported that the students had a higher self-concept after participating in the music instruction than before they participated in the program (Shin, 2011).

Additionally, children who are exposed to music training may have better working memory, as well as long-term memory (Foran, 2009). Students may also have better verbal memory than those students who do not study music (Patston & Tippett, 2011; Yim-Chi et al., 2003). Furthermore, music instruction may increase IQ levels for children (Schellenberg, 2004; Schellenberg, 2011). Patson and Tippett (2011) conducted a study (N=72) with adult musicians (n=26) and non-musicians (n=36) in which they compared language comprehension and visuospatial performance of individuals with a musical instruction background and without a musical training background. The students with musical training in their background scored higher than those students who did not have musical training in their background in the areas of language comprehension and visuospatial performance (Patso and Tippett, 2011). However, the students' IQs were not compared before the study, and the researchers were not certain whether the students with musical training backgrounds were naturally more capable students (Patson & Tippett, 2011).

Music instruction may also increase IQ levels in some children (Schellenberg, 2004). Schellenberg (2004) conducted a study with six-year-old children with no noted disabilities (*N*=144) and found IQ levels increase for students who received musical instruction. While this IQ increase was small, students in control groups of students with no instruction and students with drama instruction did not experience any increase in IQ (Schellenberg, 2004). Schellenberg (2011) conducted a similar study with 9 to 12-year-old children (no disabilities noted) (*N*=106) with musical training (*n*=50) and without musical training (*n*=56) to determine if the increase in IQ score with music lessons was mediated by executive function. Schellenberg (2011) concluded that, while executive function did improve with higher IQ scores, is not a mediating factor between music instruction and IQ increases. However, executive function has been shown to be a mediating factor in some cases (Dege et al., 2011). Dege et al., (2011) conducted a study with 9 to 12-year-old children (*N*=90), and found that executive function is a mediator in the association between music instruction and IQ. Therefore, it may be that music instruction has an indirect rather than direct effect on intelligence (Dege et al., 2011). Based on conflicting reports, further research in this area is warranted.

Music instruction's effect on literacy. Literacy in young individuals is one of the most important skills to be acquired, and it must begin at a very young age (Moritz et al., 2013). Reading instruction typically begins at the first-grade level; it is important to begin with basic reading precursors, such as phonological awareness, as early as possible (Moritz et al., 2013). Moritz et al. (2013) conducted a study in which the phonological awareness of kindergarten students (*N*=30) who received music instruction was compared to those who did not. Those students who received musical instruction showed a higher increase in their phonological awareness than those who did not ($r < -.50$) (Moritz et al., 2013). Furthermore, a follow-up study involving some of the same students (*N*=12) two years later in second grade (Moritz et al., 2013). The phonological processing skills of the students in the second grade correlated with their rhythm ability in their kindergarten year, supporting their hypothesis that rhythm ability relates to phonological awareness (Moritz et al., 2013). While music has been theorized in the past to affect reading comprehension, some recent studies have reported that to not be the case (Cogo-Moreira et al., 2015; Haning, 2016). Cogo-Moreira et al. (2015) conducted a study in which music curriculum was added for students (*N*=235) who were struggling in the area of reading to compare reading scores to a control group who did not have music curriculum added. However, the students who had the music curriculum added continued to struggle in reading even with the addition of music instruction (Cogo-Moreira et al., 2015). Haning (2016) also conducted a study in which musically trained individuals and non-musically trained individuals (both groups with no disabilities noted) (*N*=5) were provided reading comprehension tasks with and without background music playing. Haning (2016) found no significant differences in the reading comprehension skills in the musically trained individuals, nor did they find any impact of background music playing in the reading comprehension scores of students with musical training.

Music instructions effect on math. Music instruction has an effect on math achievement (Bugos & Jacobs, 2012; Cranmore & Tunks, 2015; Foran, 2009; Holmes & Hallam, 2017). A high percentage of students who participate in music instruction feel that there is a strong connection between music and math achievement (Cranmore & Tunks, 2015). Students who receive music instruction for two or more years perform better in mathematics than students who do not (Cheek & Smith, 1999). Furthermore, there is evidence that students who study the keyboard in particular for two or more years perform significantly higher mathematically than those students who study other instruments (Cheek & Smith, 1999). Bugos and Jacobs (2012) conducted a study in which sixth-grade students with no noted disabilities (*N*=28) were either enrolled in music instruction or not enrolled in music instruction. While the data did not indicate an increase in any other subject area, students enrolled in the music instruction courses performed significantly better on a mathematics post-test (Bugos & Jacobs, 2012). However, there are multiple studies conducted on the effects of music instruction on math achievement with inconclusive results, and further studies are needed to determine whether there is an actual effect (Crnec et al., 2006; McKelvey & Low, 2002; Vaughn, 2000). Students may be able to complete more problems accurately with music playing than those without music playing in the background (Hallam & Price, 1998). In fact, Mozart music in particular may affect math test scores (Taylor & Rowe, 2012). The perception of students on the connection between math and music may have an impact on their ability to perform well in both areas, and many students believe the two are connected (Cranmore & Tunks, 2015). Additionally, music incorporated into math lessons may assist students with retention of the math knowledge (Harris, 2008). However, there is some evidence that students who are mathematically talented often have musical backgrounds; i.e., music lessons, extensive musical exposure, and participation in music-related activities or clubs (Hsieh & Kuo, 2016).

Music's effect on subject areas summary. In summary, the literature supports that background music in academic settings may have a positive effect during math and reading lessons. Students who are interested in music often take courses that support this interest, whether it be learning to play an instrument, music theory, or voice. Students who take courses to study music often do better in their academic courses; however, it is uncertain whether the act of studying music affects their ability to learn or if they are possibly already prone to higher academic achievement (Cabanac et al., 2013; Dege et al., 2011; Patson & Tippett, 2011; Pelayo, 2014; Schellenberg, 2004). In some cases, the addition of music curriculum for students has no impact on their academic performance (Cogo-Moreira et al., 2015). However, students' self-report of self-concept and self-esteem in regards to their ability to achieve academically if often increased through their participation in a music instruction program (Shin, 2011).

Music's Effect on Mood

Depending upon the type of music that is played in the classroom, children can experience varying emotional responses (Mattar, 2013). Pleasant music played in the background of classrooms of normally developing children between the ages of four and six can have a calming effect (Mattar, 2013). Music can induce positive or negative mood responses, as well as various levels of positive or negative states of arousal such as elated, calm, distressed, or excited in normally developing college-aged students (Nguyen & Grahn, 2017). Listening to Mozart music can also affect the mood of individuals, which can affect behaviors and help to create an environment for learning in the classroom (Mattar, 2013; North et al., 2004; Pelayo, 2014; Waugh & Riddoch, 2007). Classical music and other self-selected music that is perceived as relaxing can help reduce negative emotions (Labbe et al., 2007). McFerran et al. (2015) conducted a study regarding the effects of various types of music have on the emotional state of adolescents (*N*=111) and found that student-selected music has a positive effect on the emotional response of mentally healthy adolescents regardless of the genre. However, students who were already experiencing sadness or depression reported that they continued to feel sad and depressed after listening to music (McFerran et al., 2015). These individuals typically chose to listen to music associated with anger (McFerran et al., 2015).

The importance of music for students. Music is very important in the lives of individuals, including children. Campbell et al. (2007) surveyed children ages 14 to 16 years old (*N*=1,155), of which 78% were female, on the importance of music in their lives. Many of the children reported that music was essential for their emotional well-being and help them to regulate their emotions (Campbell et al., 2007). The students who responded to the survey reported that music has the ability to help them regulate their emotions, especially anger (Campbell et al., 2007). The respondents to the survey also suggested that music helps them deal with "the pressures of study, family, and the dynamics of friendship and social life" (Campbell et al., 2007, p. 228). In another survey conducted by McFerran et al. (2015), the majority of adolescents who participated in the study (*N*=111) reported that listening to music improved their emotions when they were already feeling bored or happy with fewer participants reporting improvement in mood when they were already feeling sad or angry. This effect on emotions may help to explain the effect that music has on anxiety.

Effect of music on anxiety. Anxiety can be an emotional stressor that effects students academically. Students can have anxiety regarding learning new information, and music can reduce the adverse effect of the anxiety (Dolean, 2016; Jiwei, Qinghua, & Haifei, 2014; Yen-Ning et al., 2016). Anxiety can affect cognitive processes and be a barrier to success in the classroom (Dolean, 2016; Jiwei et al., 2014; Yen-Ning et al., 2016). Music helps to alleviate anxiety and negative emotions that can be barriers to success in the classroom (Dolean, 2016; Jiwei et al., 2014; Yen-Ning et al., 2016). Music played during assessments can have a calming effect on negative emotions and anxiety, which can lead to higher test scores (Dolean, 2016; Yen-Ning et al., 2016). Yen-Ning et al. (2016) conducted a study involving learning anxiety as it relates to reading ability with normally developing elementary age students (*N*=66) and found that listening to Mozart music can help reduce anxiety that is related to learning to read. The effects of teaching music during foreign language classes were shown to have a positive effect on stress related to learning a foreign language (Dolean, 2016). This reduction in stress as a result of music lessons can contribute to higher test scores (Dolean, 2016). Music's positive effect on mood and anxiety may help students focus and experience higher achievement in the classroom. Further research to explore the area of music's effect on stress and anxiety would be beneficial to the body of empirical knowledge in this area.

The effects of music on mood summary. Music has been shown to have a positive effect on the mood of individuals (Dolean, 2016; Jiwei et al., 2014; Yen-Ning et al., 2016). This effect could assist students to be better prepared to handle academic challenges. School-related anxiety can be reduced through the use of classic Mozart background music, which can lead to higher academic achievement (Dolean, 2016; Jiwei et al., 2014; Yen-Ning et al., 2016). When students feel less anxious and calmer, they may be able to focus more readily on academic topics. Overall, Mozart music has been found to have a calming effect on mood in academic settings (Yen-Ning et al., 2016).

Self-selected Music

Students may have a greater effect from music that they choose and enjoy (Cassity, Henley, & Markley, 2007; Liljestrom et al., 2012; McFerran et al., 2015). Music that students choose themselves is familiar and, therefore, may affect positive emotions (Cassity et al., 2007; Liljestrom et al., 2012). Self-selected music that is perceived by the listener as calming can help reduce negative emotions (Labbe et al., 2007). When a person enjoys the music that they are hearing, a greater amount of emotional responses can be expected, which can possibly affect "memory-based mechanisms like evaluative conditioning and episodic memory" (Liljestrom et al., 2012, p. 583). Teenagers report having a positive emotional response to music that they choose (McFerran et al., 2015). McFerran et al. (2015) conducted a survey with children ages 15 to 18 (*N*=111) who reported that listening to their favorite music made them feel better. Allowing individuals to select their music may also contribute to a feeling of control over a situation, which may evoke positive emotions toward an activity (Liljestrom et al., 2012). However, learning may be "an artifactual consequence of heightened arousal and mood rather than the music of Mozart" (Cassity et al., 2007, p. 13).

Self-selected music and anxiety. Self-selected music may have an impact on anxiety (O'Callaghan et al., 2012) and exercise (Campbell & White, 2015). Self-selected music can help reduce anxiety in some medical patients (O'Callaghan et al., 2012). O'Callaghan et al. (2012) conducted a survey to determine whether self-selected music could help reduce anxiety in radiotherapy treatment patients (*N*=100). While the anxiety of the patients was not affected by the self-selected music, the patients reported feelings of being distracted from the treatment and supported by the staff (O'Callaghan et al, 2012). A high percentage of the patients also reported a desire to have self-selected music available to them during future treatments (O'Callaghan et al., 2012). Further, Campbell and White (2015) conducted research with undergraduate students (*N*=148) who listened to student-selected music during exercise. Students reported higher levels of enjoyment and decreased levels of fatigue after exercising with student-selected music (Campbell & White, 2015).

Classical music versus self-selected music. When students perceive self-selected music as calming, including classical music, the emotional status of the listener can be improved (Labbe et al., 2007). However, music selected by individuals as calming has a higher calming effect than classical music (Labbe et al., 2007). Labbe et al. (2007) conducted a study with college students (*N*=56) in which the students were exposed to classical music, self-selected music, heavy metal music, or silence and found that the students experienced the greatest levels of relaxation under the condition of self-selected music perceived as calming. Self-selected music may be just as effective or more effective than Mozart music as a tool to increase memory and learning (Cassity et al., 2007; Liljestrom et al., 2012). Cassity et al. (2007) conducted a study in which undergraduate psychology students (*N*=38) who had experience with three-dimensional games to determine if the participants would score higher under the condition of Mozart music or the game's original soundtrack *Fight Like a Brave Man* by the Red Hot Chilli Peppers. Cassity et al. (2007) found that the male participants strongly preferred the original soundtrack over the Mozart soundtrack and scored higher on the game with the preferred music playing. However, McKelvie and Low (2002) found no difference in academic performance under the conditions of Mozart music and other types of music playing. Liljestrom et al. (2012) conducted a study in which students' emotional responses to self-selected music as compared to random music presented were monitored. Liljestrom et al. (2012) found that the students had a much higher level of emotional response to the music that individuals chose themselves as compared to random music that was presented. However, McKelvie and Low (2002) conducted a study in which intermediate normally developing school-age children (*N*=55) showed no difference in their special ability as measured by pre- and post-test Stanford-Binet Intelligence scale when given the condition of Mozart music and popular dance music. The differences in researchers' results and conclusions warrants caution.

Self-selected music summary. Very few studies focus on student-selected music and its effect on behaviors, anxiety, and academic success. However, there is some empirical data that suggests that self-selected music may affect anxiety and create positive emotional responses in individuals (Campbell & White, 2015; O'Callaghan et al., 2012). The literature review in this area supports the need for additional studies.

Music and Students with ADHD

A multitude of studies regarding music therapy and students with ADHD are prevalent in the literature (Hudziak et al., 2014, Lesiuk, 2015; Reif, 2016; Yinger & Gooding, 2014). However, there is a shortage of studies with students with ADHD that examine the effects of listening to music during lecture, independent study time, or assessments to improve academic achievement as well as decrease unwanted behaviors. Extensive research regarding how music can affect students with and without ADHD has been conducted (Hudziak et al., 2014, Lesiuk, 2015; Reif, 2016; Yinger & Gooding, 2014). Lesiuk (2015) found that there may be a link between working memory and music exposure in students ages 9 to 11. Hudziak et al. (2014) indicated that students ages 6 to 18 may be able to experience more rapid cortical thickness maturation in the brain when exposed to music; however, this study remains inconclusive based on confounding factors. Additionally, listening to music and having background music playing during academic times may have a calming effect as well as help increase academic achievement for students with ADHD (Reif, 2016). Music therapy is one type of music exposure that can be used as a strategy for students with ADHD.

Music therapy and students with ADHD. While the terms music therapy and music intervention are often used similarly, music therapy is different from music intervention. Bruscia (1998) defined music intervention as, "a systematic process of intervention wherein the therapist helps the client to promote health using music experiences and the relationships that develop through them as dynamic forces of change" (p. 47). Music therapy is implemented by a professional who has been trained via an evidence-based music therapy program (Maloy &

Peterson, 2015). The definition of music therapy has not changed significantly since that time (Maloy & Peterson, 2015). In contrast to music therapy, any teacher can implement music interventions (Maloy & Peterson, 2015).

Music therapy may also support the improvement of executive functioning deficits, including working memory, for students with ADHD (Lesiuk, 2015; Rickson, 2006). This improvement may be in part due to the influence that music therapy has on the brain, but it may also have to do with the interactions between a child with ADHD and the therapist (Yinger & Gooding, 2014). Lesiuk (2015) conducted a between-subjects control group design study with children ages 9 to 11 years old (N=71) in which executive functions were compared to music perception ability. The children who showed lower executive functioning, as is characterized by students with ADHD, showed significantly lower music perception ability (Lesiuk, 2015). Based on the findings of this study, Lesiuk (2015) concluded that children with executive functioning deficits may benefit from music-based activities. Rickson (2006) conducted a multiple contrasting treatment combined with an experimental control group design study with students ages 11 to 16 (N=13) who were diagnosed with ADHD in which instructional and improvisational music therapy was compared, and found that, while there was not a statistically significant difference in the results of the two types of music therapy, instructional therapy showed some decreases in impulsive behaviors in adolescent males.

Background music for students with ADHD. Background music playing may help students with ADHD to maintain focus on academic tasks (Pelham et al., 2011; Zentall et al., 2012). This effect of background music may be present when students with ADHD listen to classical music such as Mozart (Verrusio et al., 2015). However, background music may be applied to other types of music when the music is pleasant and soothing to the listener (Cripe, 1986; Verrusio et al., 2015). Cripe (1986) conducted a study on the effects of playing rock music while observing behaviors of students ages six to eight with ADHD (*N*=8). He found that on-task behaviors as well as social functioning increased for these students across the settings of school, home, and after-school programs while the rock music played in the background (Cripe, 1986). Pelham et al. (2011) conducted a study on male students between the ages of seven to 12 (*N*=67) both with and without ADHD diagnoses. Pelham et al. (2011) examined the effects of music, video, and an ADHD medication on the amount of distraction exhibited by the participants. Pelham et al. (2011) used music as a distractor for boys who had been diagnosed with ADHD and found that music was not a distractor for some of the students with ADHD diagnosis. Furthermore, Pelham et al. (2011) found that background music was beneficial to students diagnosed with ADHD's ability to remain focused.

Music and Students with ADHD Summary. Music research has found to have a positive effect on behaviors and attention of students with ADHD (Pelham et al., 2011; Verrusio et al., 2015; Zentall et al., 2012). Music therapy may be an effective tool for using music to assist students with ADHD to increase attention and focus (Hudziak et al., 2014; Lesiuk, 2015; Maloy & Peterson, 2015; Yinger & Gooding, 2014). Additionally, the calming effect that music has on some individuals may help students with ADHD to focus more appropriately on academics (Crncec et al., 2006; Hallam & Price, 1998; Reif, 2016). Music has also been shown to have a positive effect on attention and behaviors of students with ADHD when played in the background (Pelham et al., 2011; Verrusio et al., 2015; Zentall et al., 2012). Overall, research on music and students with ADHD suggests that music played in the background of academic settings and music therapy for students with ADHD can have a positive effect on their overall ability to remain focused and improve executive functioning, including working memory

(Hudziak et al, 2014; Lesiuk, 2015; Rickson, 2006). However, studies that are specific to the effects of music on students with ADHD are limited and require further study.

ADHD and Working Memory

Individuals with ADHD have deficits in their executive functioning, which includes behavior control, self-regulation, and working memory (Alderson et al., 2015). These deficits can affect a child with ADHD's ability to perform well academically (Bigorra, Garolera, Guijarro, & Hervas, 2016; Dovis et al., 2015b). Working memory is one's ability to store and manipulate information in the brain (Alderson et al., 2015; Bigorra et al., 2016; Dovis et al., 2015b). Working memory deficits may contribute to the behavioral and academic difficulties associated with an ADHD diagnosis (Alderson et al., 2015; Bigorra et al., 2016; Dovis et al., 2015b). Both visuospatial and phonological components of working memory can be affected (Alderson et al, 2015; Bigorra et al., 2016). Alderson et al. (2015) conducted a study in which the working memory of students with an ADHD diagnosis (*N*=32) was compared to typically developing peers. The students with ADHD performed significantly worse than typically developing students in the areas of phonological stimulus (auditory, visually, and dual presentation) (Alderson et al., 2015).

Working memory training and ADHD. The ability to improve working memory in children with ADHD may be associated with improvement in other characteristics that involve working memory deficits such as behavioral and academic issues (Chacko et al., 2013; Farcas & Szamoskozi, 2016). Working memory in students with ADHD may be able to be improved through Cogmed Working Memory Training (CWMT) (Bigorra et al., 2016; Chacko et al., 2013). CWMT is a commercially available, online working memory training program (Bigorra et al., 2016; Chacko et al., 2013). Bigorra et al., (2016) conducted a study on the effects of

CWMT on the executive function of children ages seven to 12 years old with ADHD (*N*=66). Bigorra et al. (2016) found that working memory was improved through the use of the training program. However, in a meta-analysis of seven studies that used CWMT, Chacko et al. (2013) found mixed results in the effectiveness of the program. Another possible intervention for working memory deficits may be gamified working memory trainings (Farcas & Szamoskozi, 2016). However, Farcas and Szamoskozi (2016) conducted a meta-analysis of 11 empirical studies that examined the effects of gamified working memory trainings and found that the impact that gamified working memory trainings had on individuals was trivial (overall ES=.238).

Another possible intervention for students with and without ADHD for working memory improvement is music training (Hudziak et al., 2014; Lesiuk, 2015). Lesiuk (2015) found that students with ADHD ages 9 to 11 often have deficits in working memory which may be improved through music training. Hudziak et al. (2014) found that in normally developing students ages 6 to 18 experienced a "more rapid cortical thickness maturation in the frontal parietal regions" of the brain when exposed to music training (p. 1160). Hudziak et al. (2014) conducted a study with normally developing 6 to 18-year-olds (*N*=232) in which cortical thickness was compared to the number of years that the participants had played a musical instrument. While Hudziak et al. (2014) found that years of playing an instrument and cortical thickness were not associated, cortical thickness was associated with the amount of time spent in musical training. Cortical thickness as it relates to the medial prefrontal brain is associated with inattentive behaviors, as well as hyperactivity in normally developing youth, which is compounded in youth with ADHD (Hudziak et al., 2014). Shaw et al. (2007) studied the cortical maturation of the brain in students with and without ADHD and found that children with ADHD have a significant delay in cortical maturation of three years longer than normally developing peers. Based on this information, Hudziak et al. (2014) concluded that music training may help to control certain aspects of ADHD symptoms.

Characteristics of individuals with ADHD. ADHD characteristics include inattention and hyperactivity (Chacko et al., 2013; Bigorra et al., 2016; Dovis et al., 2015a; Farcas & Szamoskozi, 2016). Individuals with ADHD often have deficits in working memory that can contribute to behavioral and academic difficulties (Bigorra, et al., 2016; Fried et al., 2016; Hudziak et al., 2014; Lesiuk, 2015). Often, children with ADHD have difficulties in the areas of reading and math based on working memory impairments (Chacko et al., 2013; Fried et al., 2016). Children with ADHD may also have motivational impairments causing them to require higher levels of reward or stimulation to become engaged in an activity (Dovis et al., 2015a; Farcas & Szamoskozi, 2016). The most common problems for individuals with ADHD are associated with visuospatial working memory (Dovis et al., 2015a; Dovis et al., 2015b).

Assessment of working memory of students with ADHD. Much of the empirical research uses visuospatial working memory and phonological working memory subtests of the Wechsler Intelligence Scale for Children and Kaufman Test of Educational Achievement to assess working memory in children (Alderson et al., 2015; Bigorra, et al., 2016; Dovis et al., 2015a; Dovis et al., 2015b; Fried et al., 2016). Another popular working memory assessment is the use of N-back tasks (Jaeggi et al., 2010; Wilhelm et al., 2013). With N-back tasks, a series of stimuli is presented to the participant and, for each stimulus, the participant's task is to determine if it is the same stimulus as "N" items before (Jaeggi et al., 2010; Wilhelm et al., 2013). N-back tasks can be effective working memory tests because it causes the participant to have to simultaneously attend to a current stimulus while remembering previous stimuli (Jaeggi et al., 2010; Wilhelm et al., 2013).

N-back tasks are used in empirical research as a measure of working memory (Dores et al., 2017; Kato et al., 2016; Scharinger, Soutschek, Schubert, & Gerjets, 2015). They have been used to measure working memory as it pertains to numerous topics, such as inhibition and updating (Scharinger et al., 2015), age-related changes in attentional control (Kato et al., 2016), and behavior (Dores et al., 2017). N-back tasks have also been used in empirical studies as a measure of working memory for students with ADHD (Bedard et al., 2014; Hudec et al., 2015; Li et al., 2014; Saarinen et al., 2015; Villemonteix et al., 2017; Wu et al., 2017). Bedard et al., (2014) conducted a study regarding the visuospatial working memory of children ages nine to 15 with ADHD (*N*=45). Deficits in visuospatial working memory are known to be linked to, "childhood presentation of ADHD and may contribute to the development of later psychopathology and academic difficulties…" (Bedard et al., 2014, p. 1020). Bedard et al. (2014) used functional magnetic resonance imaging (fMRI) on the brain of children with ADHD during the administration of N-back tasks and found evidence of visuospatial working memory deficits. In a similar study, Wu et al. (2017) also used fMRI to scan the brains of male children with ADHD during the administration of N-back tasks as compared to normally developing children and concluded that the children with ADHD "showed altered functional connectivity within several networks" (p. 1067). Villemonteix et al. (2017) conducted a study in which emotional N-back tasks (pictures were either of negative images, positive images, or neutral images) were given to students with ADHD and typically developing students, all ages 8 to 13 years of age (*N*=58). While all of the students performed better with the neutral images than the negative ones, students with ADHD performed worse on the task overall, supporting working memory deficits in students with ADHD (Villemonteix et al., 2017).

N-back tasks can use auditory stimulation or visual stimulation (Jaeggi et al., 2010; Wilhelm et al., 2013). An extensive search of ERIC, Academic Search Complete, and Education Research Complete databases with the keywords, "N-back, Cognitive Fun, working memory, and ADHD," and no empirical data were found on any particular software or program that was used to administer the N-back tasks. Rather, the tests were described in detail regarding the type of N-back test being administered. The N-back tasks are described in details regarding whether it is visuospatial or auditory, and if it is visuospatial, whether it uses pictures, shapes, dots placed in specific areas of a screen, or numbers. Also, the research describes whether 0-back, 1-back, or 2-back tasks are used for their research.

Summary

When students are satisfied with their educational environment, find the environment engaging, and have positive experiences in class, student learning is fostered (Childers, Williams, & Kemp, 2014). Childers et al. (2014) conducted a study with university students (*N*=144) to determine if environmental factors significantly affect student satisfaction and found that "the arousal dimension of our selected environmental factors—music [played in the background of their instructional setting], instructor attitude, and instructor lecture—had significant effects on student satisfaction" (p. 10). Research suggests music has a positive effect on mood, behavior, and achievement (Childers et al., 2014; Liljestrom et al., 2012). However, further research and information are necessary to understand the clear implications of the effect music may have on students. Much of the literature available focuses on the effects of music on students with ADHD, and much of the data supports the fact that children with ADHD require more stimulation than other students in order to focus and perform well (Pelham et al., 2011). Music appears to be a stimulating factor that assists children with ADHD to focus and retain more information than when they do not have music playing (Pelham et al., 2011). While many studies have been conducted regarding the effects that music has on behaviors and academic achievement among students and other groups of individuals, there has been no research on the effects of self-selected music for students with ADHD, nor the effect of listening to self-selected music on working memory. In fact, studies regarding self-selected music with any group of individuals are scarce.

Music as an intervention or classroom strategy can have a positive impact on academic deficits in students with ADHD (Maloy & Peterson, 2015). The idea that music in the classroom could affect the learning behaviors of students is intriguing. Should music affect behavior and academic success for students in a classroom, it could be an instrumental tool in solving a myriad of issues within the classroom. Young people can be observed in schools and outside of schools listening to music through headphones with personal listening devices. The technology that allows individuals to do so has permeated society (Campbell et al., 2007; Hallam et al., 2002). Could students with ADHD retain more information if they are allowed to choose their music during study time or assessments? Is it possible that listening to their choice of music through headphones while studying newly introduced material could assist them with retention? Allowing students to listen to music of their choice through the use of individual listening devices, and the effect that this action might have on behavior and learning requires further study to be fully understood.

CHAPTER THREE: METHODS

Overview

In this chapter, the study's research design is identified, discussed, and aligned with its purpose. First, the study's design is explained, along with how it addresses the research question and hypotheses of this study. Next, the participants and the setting of the study are described. Additionally, a description of the sample and the sampling method is included. The instrument section addresses reliability and validity statistics. A detailed description of the study procedures is included. Each of the seven quality indicators published by the Council for Exceptional Children (2014) are also thoroughly addressed. Finally, a description of the data analysis that was conducted are discussed, including effect size.

Design

This study used an ABACAC single-subject design with multiple treatments (Byiers, Reichle, & Symons, 2012) to investigate the effects of self-selected music on the working memory of students with ADHD. This design was chosen based on the unique needs and differences of students with ADHD (Byiers et al., 2012). A single-subject design "involves the intense study of one individual or more than one individual treated as a single group" (Gall, Gall, & Borg, 2007, p. 426). Single-subject research does not refer to the number of participants in the study; rather, it refers to the process that is used to conduct the research (Neuman & McCormick, 1995). Single-subject research allows the researcher to obtain a highly personalized analysis of individual data that can represent replication of a study over several subjects (Neuman & McCormick, 1995).

Single-subject is an experimental design that is useful in explaining relationships between variables, and it is quite common in special education research (Gall et al., 2007; Horner et al., 2005). The analysis of highly personalized data that is afforded by single-subject design allows researchers to gather information regarding how treatments affect individuals (Neuman & McCormick, 1995). The single-subject design is most appropriate for the current research because the research focuses on the relationship between music and working memory in individual students who have been medically diagnosed with ADHD (Gall et al., 2007; Horner et al., 2005). Research involving special education students often uses the single-subject research design due to the highly individualized results that may be obtained for these students and limited access to special populations (Byiers et al., 2012; Neuman & McCormick, 1995). Meeting the needs of students with ADHD in special education is based on highly individualized needs (Bateman & Cline, 2016). A federal law that directs the education of all students in the United States mandates that schools determine, “the individual needs of the student and build[ing] a program that addresses those needs” (Bateman & Cline, 2016, p. 36).

A multiple-treatment design is utilized when more than one treatment is being implemented (Byiers et al., 2012). Byiers et al. (2012) stated that “the most straightforward design [single-subject] of this type is the ABACAC design, which begins with an ABA design and is followed by a CAC design” (p. 406). The A phases of the design represent baseline data (no music). Baseline data were collected over a minimum of five sessions or until stability of the data was achieved for students to demonstrate their pre-intervention abilities and to establish a stable trend (Byiers et al., 2012; Neuman & McCormick, 1995). Sessions were held on separate days and lasted approximately 10-15 minutes each. “Stability is assumed when a student’s data show a similar level of responding across several measurement sessions” under the same condition (Neuman & McCormick, 1995, p. 9). Baseline data, which is the A condition of the research, was followed by the B condition of classical music presented, and data were collected over five sessions (Byiers et al., 2012). Condition A (no music) was repeated after the B condition (classical music) over five sessions to complete the first part of data collection (Byiers et al., 2012). The first three phases (ABA) was followed by CAC, with the C representing student-selected music and A representing a return to baseline (no music) (Byiers et al., 2012). The ABACAC design was most appropriate for this research because baseline data (no music present), and data for two treatments, classical music (B) and student-selected music (C) was collected (Byiers et al., 2012). The independent variables of classical music and self-selected music may affect the dependent variable of working memory. Including baseline data between the two treatment conditions increases internal validity by controlling for serial dependency, which is when a behavior within a session is believed to have been caused by or influenced by behavior in a previous session (Byiers et al., 2012).

The participants for this study were drawn from a convenience sample of middle school students located in a central Virginia middle school, Horizon Middle School (pseudonym), during the 2018-2019 school year. Horizon Middle School is located within the Horizon County Public Schools (pseudonym), which consists of one elementary school, one middle school, and one high school. A convenience sample of fifth-grade students was selected based on their status as students receiving special education services as a child with ADHD. Horizon Middle School was selected based on location and convenience. Students within Horizon Middle School were selected to participate based on their status of receiving special education services and having a medical diagnosis of ADHD. Participants were similar in age, grade, and ADHD diagnosis.

Research Question

The research question presented below was investigated:

RQ1: Does student-selected music listened to through headphones by fifth-grade students with an ADHD diagnosis increase working memory measured by online N-back tasks, as compared to no music or teacher-selected classical music?

Hypotheses

The null hypotheses for this study are:

$H_0$1: Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to no music.

$H_0$2: Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to teacher-selected classical music.

Participants and Setting

As recommended by the CEC standards of quality, this section provides participant and setting selection (Horner, et al., 2005; Kratochwill, 2003) and inclusion criteria (Kratochwill, 2003). Participant characteristics (Cook et al., 2014; Horner et al., 2005; Kratochwill, 2003) are described with sufficient detail to allow future researchers to select students with similar attributes (Horner et al., 2005). The participants for this study were drawn from a sample of middle school students located in a central Virginia middle school, Horizon Middle School (pseudonym), during the 2018-2019 school year. Horizon Middle School is located within the Horizon County Public Schools (pseudonym), which consists of one elementary school, one middle school, and one high school. Horizon County Public Schools has approximately 1,808 total students enrolled within the district. The school system is approximately 66% white, 23% African American, 5% Hispanic, and 6% some other nationality or more than one race (see Table

1). Approximately 46% of Horizon County Public School students are economically disadvantaged (see Table 1). Horizon Middle School has approximately 500 students enrolled and includes grades five through eight. Horizon Middle School is approximately 60% white, 25% African American, and 15% some other nationality or more than one race (see Table 1). Approximately 48% of students are free and reduced lunch eligible (see Table 1). Horizon Middle School has five fifth-grade classes with 28 to 35 students in each class. A convenience sample of five fifth-grade students were selected based on their status as students receiving special education services and ADHD (Horner et al., 2005). Horizon County Public Schools has approximately six students enrolled in the fifth-grade who receive special education services as a student with an ADHD diagnosis.

Table 1

Demographics of Horizon Public School and Horizon Middle School

	Horizon Public School System	Horizon Middle School
Students Enrolled	1,808	500
White	66%	60%
African American	23%	25%
Other Nationality	11%	15%
Economically Disadvantaged	46%	48%

Single-subject designs can be conducted with only one participant (Gall et al., 2007; Horner et al., 2005). However, single-subject designs typically include three to eight participants (Horner et al., 2005). For the purpose of replication and increased external validity, the researcher attempted to obtain parental permissions for six students to participate (Horner et al., 2005; Neuman & McCormick, 1995). With the approval of administration and parents, six students were asked to participate in the research study.

Informed consent from parents was received by five students (see table 2). Approvals were also received by the division superintendent and school principal. Students participated in the study individually at times based on their schedules to not disrupt instruction time. All students participated during non-academic times of the day, and the setting was a quiet room with few distractions. Other individuals in the room were limited to only the researcher and/or the student's special education teacher, and the only other children in the room were other participants in the study. For this single-subject design study, no students were placed in groups as described in CEC standards of quality based on the nature of the design (Neuman & McCormick, 1995).

The study was completed during the school day; however, distracting elements, such as individuals entering the room during the process, bells ringing, people talking, and people moving about in the room, were eliminated as much as possible. Any distractions that occurred during data collection were documented through the use of a Record of Research Session Form (Appendix A). No issues occurred regarding students not having their medication on a particular day during testing sessions. Pseudonyms have been used for each student who participated in the study.

Table 2

Participant Demographics

Name	Age	Male/ Female	Grade Level	Race	Comorbid Disabilities	Medicated for AHDD	Regularly Listens to Self-selected Music
David	10	Male	5th	Caucasian	Hearing Loss	Yes	Yes
Melinda	10	Female	5th	Caucasian	None	No	No
Stephanie	10	Female	5th	Caucasian	None	No	No
Zachary	10	Male	5th	Caucasian	Anxiety	No	Yes
Jacob	11	Male	5th	Caucasian	No	No	Yes

Instrumentation

The purpose of this study was to determine whether students with ADHD demonstrate increased concentration and memory while listening to student-selected music. The instrumentation selected was based upon the measurement of the dependent variable, the study design, the ability to administer the assessment with flexibility, and the ability to be used repeatedly over a period of time (Horner et al. 2005).

Students with ADHD have a difficult time with attention and focus (Cook et al., 2014; Gaastra et al., 2016; Zentall et al., 2012). Attention is a difficult characteristic to measure; however, one way to measure a student's ability to maintain focus is to measure their working memory (Conway et al., 2003; Engle, 2010). Attention is often connected to working memory, which is also challenging for students with ADHD (Conway et al., 2003; Engle, 2010) . This research examined the effects that student-selected music may have on the working memory of students diagnosed with ADHD. For this single-subject design, the working memory of five students was examined during phases with (a) no music, (b) self-selected music, and (c) classical music, to determine if working memory increases while listening to self-selected music.

Working Memory

Fifth-grade students with an ADHD diagnosis participated in on-line working memory tasks to determine what effects that self-selected music had on working memory. Engle (2010) explains working memory as "a system of domain-specific stores or formats for temporarily representing information along with a domain-general supervisory or executive attention mechanism" (p. S17). Working memory "require[s] the active maintenance of information in the face of concurrent processing and interference and therefore recruit an executive attention-control mechanism to combat interference" (Conway et al., 2003, p. 551). A person's working memory is his or her ability to attend to information that is presented at the moment and is one of the executive functions essential to performing well on tasks (Klingberg et al., 2002; Lesiuk, 2015). Working memory is thought to be directly related to the functioning of the frontal lobe of the brain (Klingberg et al., 2002; Miyake et al., 2000). It is also believed that students with ADHD also have improper functioning of the frontal lobe of the brain which may be why students with ADHD often have difficulties with working memory (Klingberg et al., 2002; Lesiuk, 2015). Working memory is thought to be associated with one's general intelligence which is also linked to the functioning of the prefrontal cortex in the brain (Conway et al., 2003). Improving working memory in children with ADHD could help reduce or even eliminate the effects of ADHD in children (Klingberg et al., 2002; Westerberg & Klingberg, 2007). Improving the working memory in children with ADHD could also help them improve in tasks that impact their ability to do well in school (Klingberg et al., 2002).

Assessment of Working Memory. The literature indicated three methods of measuring working memory: N-back tasks, the visuospatial working memory and phonological working memory subtests of the Wechsler Intelligence Scale for Children, and Kaufman Test of Educational Achievement (Alderson et al., 2015; Bigorra, et al., 2016; Bedard et al., 2014; Dovis et al., 2015a; Dovis et al., 2015b; Fried et al., 2016; Hudec et al., 2015; Li et al., 2014; Saarinen et al., 2015; Villemonteix et al., 2017; Wu et al., 2017). However, the Wechsler Intelligence Scale for Children and the Kaufman Test of Educational Achievement were inappropriate for the nature of this study because the differences in working memory were examined over several trials in a short period of time. For the purposes of this study, the N-back task was chosen based on the ability to repeat the task over a short period to determine whether applying variables had an effect on working memory (Jaeggi et al., 2010; Wilhelm et al., 2013). An N-back task could be applied under the conditions of no music, classical music, and student-selected music present to determine if the working memory changes among the variables (Jaeggi et al., 2010; Wilhelm et al., 2013). Additionally, the N-back task was a prevalent measure of working memory in the research as it pertains to students with ADHD (Bedard et al., 2014; Hudec et al., 2015; Li et al., 2014; Saarinen et al., 2015; Villemonteix et al., 2017; Wu et al., 2017).

N-back tasks. The working memory of students with ADHD diagnoses in this study were measured through online N-back tasks (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013). N-back tasks measured a person's working memory through an ongoing test that rapidly showed a word, picture, number or special pattern in quick order, and the subject must indicate if the current stimulus is the same as the one presented an N-back number of times, typically from one to three times (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013). A one-back task would have the participant indicate when a stimulus is the same as one picture back, and a two-back task would have the participant indicate when a stimulus is the same as one they saw two times back (DeDe, Ricca, Knilans, & Trubl, 2014). For example, when participating in a 2-back task, if a person sees the same picture or symbol as two pictures ago, the participant would indicate so by pressing a button (Conway et al., 2003; Wilhelm et al., 2013). This activity measures working memory because a person must not only remember the stimulus from a number of times ago, but they must also continuously update the stimulus (Conway et al., 2003; Wilhelm et al., 2013). Some types of N-back tasks used in current research are (a) emotional N-back tasks that use pictures that stimulate emotion (Villemontiex et al., 2017); (b) numbers or symbols as N-back stimuli (DeDe et al., 2014; Wu et al., 2017); (c) visuospatial N-back tasks that involve the placement of an object within a grid (Bedard et al., 2014; Dores et al., 2017; Saarinen et al., 2015); (d) categorical N-back tasks that require the current stimulus to be in the same category as a number of stimulants back such as they are both animals (Li et al., 2014); (e) visual N-back tasks that involve pictures or symbols only (DeDe et al., 2014; Hudec et al., 2015; Kato et al. 2016).

The N-back task was chosen for this research because it is reliable, valid, and less complicated than some other working memory tests, as well as its ability to be repeated within short periods of time (Conway et al., 2003; Jaeggi et al., 2010). Specifically, the visual N-back task was chosen for this research based upon the fact that music was be added to the N-back task, and other types of N-back tasks would provide another level of distraction that is not required for this research. The criteria of an N-back task are that words or objects are displayed in a series and the participant presses a key when they see the same image that was presented a specified number of times back. For example, if the task is a two-back task, the participant is asked to press a key when they see the same word or object that they saw two times back (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013).

Cognitive Fun! (2008) is an online free resource that provides multiple tests for attention, perception, executive function, item span, memory, and experimentation. While the Cognitive Fun! (2008) website has not been used in previous research, it meets the criteria of an N-back working memory test, specifically the visual N-back task that was necessary for this research due to the addition of music during the implementation of the working memory test. This type of instrument has been used in working memory research and is considered valid and efficient (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013). N-back tasks are “arguably a very efficient method for assessing WMC [working memory capacity] because it enables continuous recording of performance at a high rate” (Wilhelm et al., 2013, p. 16). Additionally, according to Engle (2010), N-back tasks are almost exclusively used in magnetic resonance imaging (MRI) studies, as well as research involving cognitive neuroscience. N-back tasks have been used in research as a measure of the working memory of children, including children with ADHD (Karatekin, Bingham, & White, 2009; Villemontiex, 2017; Zhao-Min et al., 2017).

For this study, N-back tasks were used to analyze working memory of students diagnosed with ADHD under three conditions: (a) no music, (b) self-selected music, and (c) teacher-selected music (classical). Self-selected music was defined as music that the student selects themselves. The students informed the researcher of his or her favorite music, and the music was purchased by the researcher, downloaded onto individual MP3 players, and provided to the students for phase C, self-selected music. Parental approval was obtained to allow the students to select their music. The teacher-selected music was Mozart’s sonata for two pianos in D major, K488. This piece was chosen as it was the piece used in the original study from which the

Mozart effect was coined (Rauscher et al., 1993). For the purposes of this study, the researcher used the working memory N-back task available on the Cognitive fun! (2008) website, which is publicly available and free. Using the Cognitive fun! (2008) online based N-back working memory test allowed all students to be tested under the same conditions, and data were collected through the online program which can help to control for human error in data collection.

Reliability. The reliability of N-back tasks has been examined and studied by multiple researchers (DeDe et al., 2014; Jacola et al., 2014; Jaeggi et al., 2010; Kane, Conway, Miura, & Colflesh, 2007). Jaeggi et al. (2010) found that the 1-back task has been proven to be the most reliable N-back task statistically (r = .94). However, the 2-back task was the second most reliable n-back task after the 1-back task (r = .86) (Jaeggi et al., 2010). Some researchers suggest using caution when applying N-back tasks as reliable measures of working memory due to mixed results in reliability testing (Jaeggi et al., 2010; Kane et al., 2007). However, DeDe et al. (2014) conducted a study on people with aphasia (N=12) to determine the reliability of various working memory tests and found that "2-back tasks demonstrate acceptable reliability in the controls (r = .74)" (p. 707).

Validity. As is required by the CEC's standards for evidence-based practices (2014), N-back tasks are a valid instrument for measuring working memory (Dores et al., 2017; Jacola et al., 2014; Kane et al., 2007). Several researchers have conducted studies to determine the validity of N-back tasks as a measure for working memory and concluded that the N-back task is a valid instrument for measuring working memory (Dores et al., 2017; Jacola et al., 2014; Kane et al., 2007). Kane et al. (2007) conducted a study with undergraduate college students (N=132) and found that the N-back task has face validity for measuring working memory. Dores et al. (2017) conducted a study to determine the validity of N-back tasks as a measure of visual working memory by examining the brain through fMRI of healthy participants and those with working memory deficits due to brain injury (*N*=10). Dores et al. (2017) found that the N-back task is a valid tool for this type of research. Additionally, Jacola et al. (2014) found evidence that supported the validity of N-back tasks. However, research conducted by Dede et al. (2014) cautions against relying on the N-back task as a valid instrument for measuring working memory.

Fidelity. Working memory was measured using an online N-back task, Cognitive Fun! (2008) during all phases of data collection. N-back tasks have been found to be a reliable measure of working memory (Conway et al., 2003; Jaeggi et al., 2010). To ensure that all CEC standards for fidelity were met, a script was used at the beginning of data collection ensure that the program was implemented consistently, and a teacher monitored the participants at each data collection session throughout all phases of data collection to ensure fidelity. The researcher or teacher also monitored implementation of the conditions of teacher selected music and student selected music to ensure that the interventions were applied consistently. The teacher who assisted the researcher with this project is a certified teacher licensed in the state of Virginia with a BS in elementary education grades 4 through 8 with math and science concentration and a special education endorsement for grades K-12, as well as a mentor endorsement. She also has 29 years of teaching experience in the public school system.

Items. The Cognitive Fun! (2008) uses at least eleven different cartoon images that are randomly flashed on the screen. The images remain on the screen for approximately two seconds before the next item is displayed. The images include items such as a car, boot, pencil, heart, baseball, cat, and cheese. All images are alike in drawing quality and size. Figure 1 provides examples of images from the Cognitive Fun! (2008) program.

Figure 1. Example images from Cognitive Fun! (2008)

Scoring. The participant was asked to click on an image when the current picture was the same image a number of images ago. For the purposes of this research, a 2-back task was used. Therefore, the participant clicked on the image if it was the same image seen two images back. If the participant was correct, he or she saw an “O” on the screen beside the image. If the participant was incorrect, he or she saw a red “X” on the screen beside the image. Once the program collected enough data during the trial to provide a score, it puts a message on the screen that a score is available. The score is the percentage of correct answers during the trial.

Each participant was logged into a previously established account for data tracking purposes. The researcher had access to each student’s account that was coded only with a password previously established with no identifying information on the account. The researcher was able to log into each participant’s account to collect the data for each student. While some students with ADHD also have other disabilities such as reading or math difficulties, these deficits should not impact the students’ ability to complete the N-back tasks as pictures are used with no words or numbers (Cognitive Fun!, 2008). Fidelity of the instrument to be used was controlled by proper monitoring of the students’ usage of the website to ensure the tool is used as intended throughout the data gathering process.

Procedures

The study of the effects of student-selected music on the working memory of students with ADHD used information gathered from online N-Back trials under the conditions of student-selected music, teacher-selected music (classical), and no music. This section begins with an explanation of how permissions were obtained for the study from the participants and their parents. Next, a description of how the researcher collected data is presented. Lastly, the data organization is explained.

Consent

Horizon County Public School's superintendent was contacted and has provided written permission for the research to be conducted within his division (Appendix B). Liberty University Institutional Review Board (IRB) approval was requested and received (Appendix C), as well as approvals from the school system. Horizon Middle School was selected based on location and convenience. Students within Horizon Middle School were selected to participate based on their medical diagnosis of ADHD. Participants were similar in age, grade, and ADHD diagnosis. Once approvals were received from IRB, school personnel sent a letter home to fifth-grade parents of students receiving special education services based on an ADHD diagnosis in order to describe the research planned in detail (Appendix D). The letter was accompanied by an informed consent form (Appendix E) that they could return should they wish to provide consent. The letter and consent form explained the nature of the study, assure confidentiality of all information, and request permission for students to participate in the study. Five out of the six consent forms were returned by the parents. With parental permission, student assent was requested by providing the students with an assent form to sign (Appendix F), and all five students signed the assent form. No identities of students were revealed to the researcher until appropriate permissions were received, and pseudonyms were used in the study.

Five of the students returned their parental informed consent forms to their special education teacher who provided the information to me. Because consent was received from five fifth-grade students, it was not necessary to reach out to other grade levels.

Data Collection

Once parents return informed consent forms and student assent was received through signed documentation from the students, a follow-up parent questionnaire (Appendix G) was sent to the parents who provided permission obtaining the following demographic information for reporting purposes:

- Medicated/not medicated (Students were not be included or excluded based on medication usage.)
- Comorbid disabilities
- Male/Female
- Age/grade level (repeated grade level if applicable)
- Does the student regularly self-select and listen to their own music?
- Will the student be allowed to bring a personal music playing device with their choice of music to school on days when self-selected music data is being collected?
- Do you wish to monitor your child's self-selection of music?

Meeting the CEC standards of quality (2014), an alternating treatment of design (ABACAC) was utilized (Byiers et al., 2012). Data were collected on each subject individually, with an ABACAC design (Byiers et al., 2012). Using the recommendations of CEC standards of quality (2014) and Cook et al. (2015) of at least three data points for each experimental effect, at least five data points were recorded in each of the following six stages of the research:

- A - No music, without headphones (baseline)
- B - Classical music, with headphones

- A - No music, without headphones
- C - Student-selected music, with headphones
- A - No music, without headphones
- C - Student-selected music, with headphones

Baseline data were collected systematically and controlled as required by CEC standards of quality (2014). Data collection sessions lasted no more than approximately 20 minutes per day once baseline data were established, and the length between data collection points was at least one day. Initial baseline data took longer for some students in order to establish the stability of the data (Gall et al., 2007). A minimum of three baseline data points was required by CEC standards of quality; however, for this research, at least five baseline data points were obtained. Scores from the N-back tasks were collected as data points during each session. At least five data points were collected within each condition to allow for "the use of multiple frequent measurements [which] provides a clearer, more reliable description of how the child's behavior naturally varies and how it varies in response to the treatment condition" (Gall et al., 2007, p. 431). Baseline data were collected until the stability of the data occurred (Gall et al., 2007).

Two factors that can affect baseline data are the learning curve and serial dependency. A learning curve is anticipated with the N-back task during which time a positive slope can be present, and data was collected until stabilization occurs. Additionally, serial dependency is when a behavior within a session is believed to have been caused by or influenced by a behavior in a previous session (Gall et al., 2007; Vries, Hartogs, & Morey, 2015). CEC standards of quality (2014) advocate establishing a separation of baseline and treatment conditions. This was accomplished by controlling for serial dependency by placing a baseline session between each session of music being implemented (Byiers et al., 2012).

External validity is the ability to generalize results from one or a few subjects to others (Neuman & McCormick, 1995). External validity was controlled by establishing generality through direct replication (Neuman & McCormick, 1995). Direct replication occurred through the same experiment being conducted with multiple subjects who were similar to one another (Neuman & McCormick, 1995). Internal validity was naturally controlled with the single-subject design through, "systematic initiation and withdrawal of treatment, the use of subjects as their own controls, and the ongoing measurement of effects over time" (Neuman & McCormick, 1995, p. 116). Additionally, threats to validity were managed through procedures implemented to ensure consistency in time of day, individual collecting data, and setting. Reduction in threats to validity was also accomplished through an established schedule for data collection regarding the time of day, consistent individuals participating in data collection (only the researcher and one assistant), and consistent timing of data collection.

Data Organization

At the beginning of each research session, each participant was asked to sit facing their individually issued Chromebooks. To meet CEC standards of quality (2014), training and intervention procedures were reviewed with a script (Appendix I) used during the beginning research sessions to ensure fidelity in the implementation of the software and continuity between research sessions. After the first few sessions, students were able to log onto the website and begin their N-back tasks independently without the use of the script. As recommended by CEC standards of quality (2014), materials included a username and password for each participant to be used as their account for data collection purposes (Appendix H), along with scripted instructions on how to use the program. Their user names and passwords were saved on their

Chromebooks, as well as maintained by the researcher. The log-in information with participant names was stored in a locked and secure location. The researcher had access to each student's account for data collection. Within the Cognitive Fun! (2008) website, the software tracks the percentage of correct answers for each attempt at the N-back working memory task and stores data for each attempt. The percentages of correct answers were used as data points for data analysis.

Data Analysis

A visual representation of the data collected by each subject was created with six sessions for each subject. Data were collected from all participants simultaneously except when circumstances required separate sessions for individuals (absent or unavailable during regular session times). The sessions occurred on average three times weakly at the same time of day and location when possible; however, some sessions occurred at different times or more or less frequently based on the availability of the student. A special education teacher currently employed at Horizon Middle School agreed to assist with data collection, and permissions were received from her supervisors for her to do so. An online program was used to collect and store data for retrieval, with each participant having an individual log-in for data collection purposes. Specifically, data were collected on the scores achieved on the N-back working memory tasks (Conway et al., 2003; Engle, 2010; Wilhelm et al., 2013). Based on CEC standards of quality (2014) and Cook et al. (2015) the data were plotted on line graphs for visual comparison (Gall et al., 2007). Data collected was evaluated visually for the following information: (a) the level (at what level did the student perform under each condition; is there any overlap in the level between conditions), (b) trend (slope), and (c) variability (the amount that the performance varies within each condition) of the data (Horner et al., 2005). The visual analysis of data gathered and plotted online graphs is the most appropriate for a single-subject study in order to compare various conditions to determine differences among conditions applied (Gall et al., 2007). Once the data were graphed, it was visually analyzed among the phases for the following information:

- Did the student score higher, lower, or the same while listening to student-selected music?
- Did the student score higher, lower, or the same while listening to classical music?
- Did the student score higher, lower, or the same while listening to no music?

A functional relationship was established or rejected based on the visual analysis of any overlap that may exist in data points between the conditions and baseline data, the magnitude of variance in the data points between conditions, and the consistency of the data points between repeated conditions (Horner et al., 2005). If the data points overlap, do not have a significant variance, and are inconsistent between repeated conditions, no functional relationship can be established (Horner et al., 2005).

Effect size is, "an index of the strength of association between two variables or of the magnitude of the difference between means" (Warner, 2013, p. 1084). Calculating the effect size for this single-subject design study was accomplished through a percentage of non-overlapping data (PND) (Dunn et al., 2017; Kim & Kimm, 2017; Pyle & Fabiano, 2017). PND was originally developed in 1987 as an effective measurement of treatment effects in single-subject design research (Scruggs & Mastropieri, 2013), and continues to be applied to single-subject design research in the area of special education (Dunn et al., 2017; Kim & Kimm, 2017; Pyle & Fabiano, 2017). PND is, "the proportion of data observed in treatment phases that did not overlap data observed in the baseline phase" (Scruggs & Mastropieri, 2013, p. 11). The PND method is the most popular method of calculating the effect size for single-subject design research, as well as easy and reliable (Dunn et al., 2017; Scruggs & Mastropieri, 2013). However, caution was applied when calculating PND in regards to the fact that one outlier data point could impact the overall effect size (Dunn et al., 2017). For this single-subject design study, PND was calculated by the percentage of non-overlapping data points in the treatment phase of student-selected music and teacher-selected music with the baseline data of no music. PND effect sizes from 0-49% is low (ineffective treatment), 50% to 69% is a medium (or questionable treatment) effect size, from 70% to 89% is a high effect size (effective intervention), and from 90% to 100% to be a very high (very effective intervention) (Dunn et al., 2017; Kim & Kimm, 2017). P levels were calculated using Microsoft Excel's formula for binomial distribution probability.

Summary

A single-subject design was used for this research investigating the effects of listening to self-selected music on working memory for fifth-grade students with ADHD. A convenience sample of five fifth-grade students from a rural, central Virginia middle school was used for this research. The students were chosen based on grade level and ADHD diagnosis. Parents were contacted to obtain permission before data collection, as well as assent from the students. Students participated in multiple trials of an online N-Back task that was designed to measure working memory. The N-Back task was implemented under three conditions: student-selected music, teacher-selected music (classical), and no music. Data were collected under each condition regarding the performance on the N-Back task. The data were plotted on line graphs and analyzed visually for overlap, variance, and consistency among the conditions.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this study was to examine the effects of self-selected music on the working memory of fifth-grade students with an ADHD diagnosis. A single-subject design was used to compare the working memory of five fifth-grade students as measured by an on-line N-back task, Cognitive Fun! (2008). The on-line N-back task was performed under the conditions of no music, teacher-selected music, and student-selected music. Two null hypotheses were tested using these conditions.

Research Question

RQ1: Does student-selected music listened to through headphones by fifth-grade students with an ADHD diagnosis increase working memory measured by online N-back tasks, as compared to no music or teacher-selected classical music?

Null Hypotheses.

$H_0$1: Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to no music.

$H_0$2: Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to teacher-selected classical music.

Descriptive Statistics

During phase one, baseline data were collected under the condition of no music present during an on-line working memory N-back task, Cognitive Fun! (2008). A minimum of three data points is recommended for phase one baseline data; however, more may be necessary to establish a predictable trend in the data (Gast & Ledford, 2014; Horner et al., 2005). For the purposes of this study, at least five data points were collected for each student to ensure the stability of the data (Gall et al., 2007). Each data point collected was calculated from an average of five trials using the online working memory N-back task, Cognitive Fun! (2008). During phase two, students completed the on-line working memory N-back task, Cognitive Fun! (2008) under the condition of listening to teacher-selected music (Mozart's sonata for two pianos in D major, K488). Two more phases of the on-line working memory N-back task, Cognitive Fun! (2008) were completed under the condition of self-selected music, with a baseline phase (no music present) between each phase to prevent serial dependency which is when a behavior in a phase of data collection could be caused by information presented in a previous phase (Byiers et al., 2012). Based on CEC standards of quality (2014), clear graphical representation is found below and throughout chapter four.

Table 3

Mean, Median, and Standard Deviation for All Phases

	Phase 1: Baseline	Phase 2: Teacher-selected Music	Phase3: Baseline	Phase 4: Self-selected Music	Phase 5: Baseline	Phase 6: Self-selected music
Mean	49.41	46.48	29.16	33.34	36.08	31.69
Median	37.19	44.20	35.8	32.94	34.03	31.92
Standard Deviation	22.33	16.17	13.46	5.47	11.31	6.97

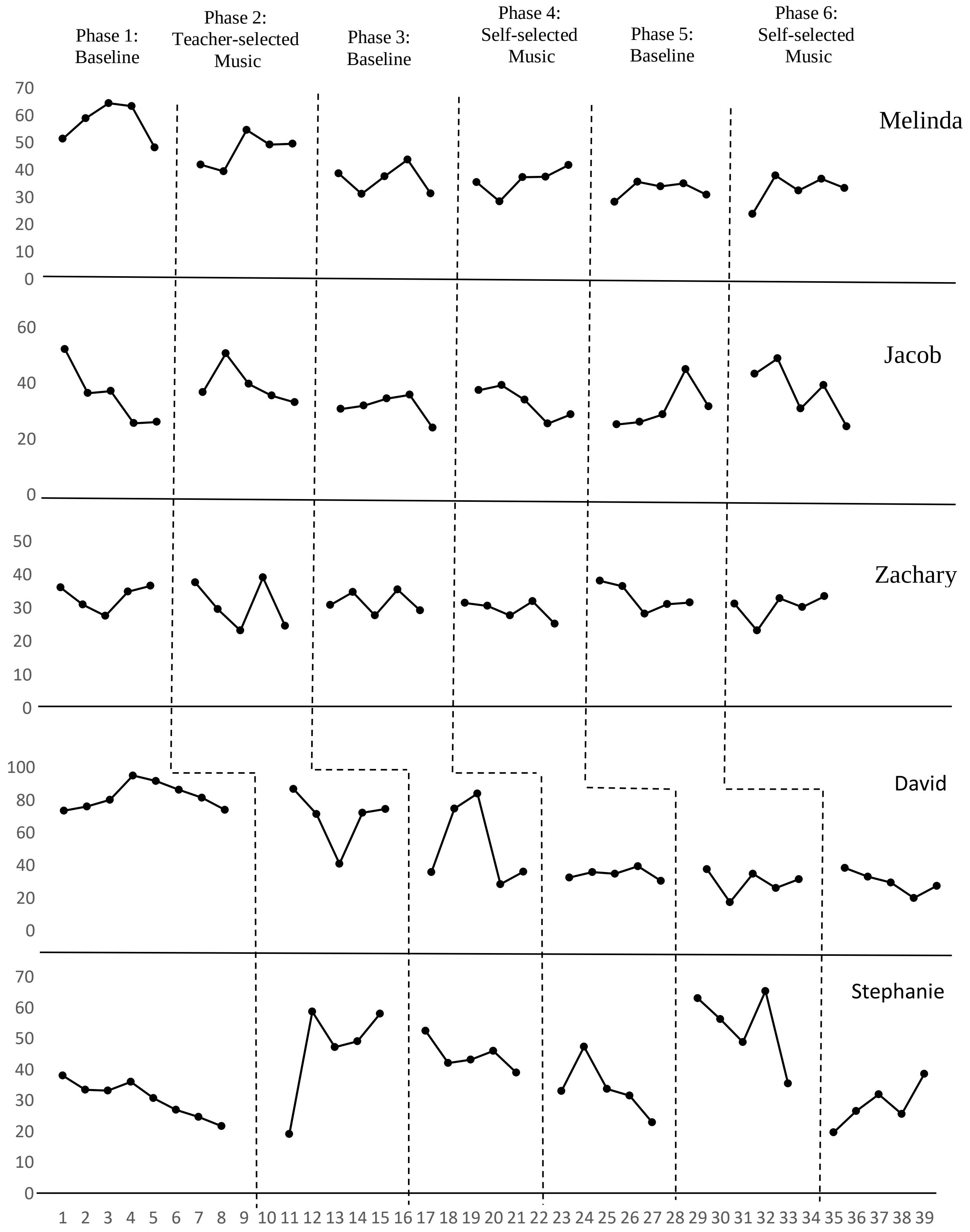

Figure 2. All phases, all participants

David (Pseudonym)

David was a ten-year-old Caucasian male in the fifth-grade with an ADHD diagnosis. David's parent indicated that he had some difficulty with hearing loss, but that he regularly listens to self-selected music. David was medicated for his ADHD. David's special education teacher indicated that he was disinterested in participating with the study and was not motivated by the treats provided daily. She also noted that David's behaviors decline in the afternoon. However, David participated in each session in the morning and completed all phases of the study.

Melinda (Pseudonym)

Melinda was a ten-year-old Caucasian female in the fifth-grade with an ADHD diagnosis. Melinda's parent indicated that she had no comorbid disabilities. The parent also indicated that Melinda did not take medication for ADHD and that she did not regularly listen to self-selected music. Melinda's teachers indicated that she was not very social, and has few friends. Melinda was motivated throughout the research sessions to work for daily treats.

Stephanie (Pseudonym)

Stephanie was a ten-year-old Caucasian female in the fifth-grade with an ADHD diagnosis. Stephanie's parent indicated that she does not have any other disabilities. The parent also indicated that Stephanie takes several medications. Stephanie regularly listens to self-selected music. Her teacher indicated that she gets along well with her peers and has no behavior issues. She is a hard worker in the classroom and wants to please her teachers. Her teacher also indicated that she did her best throughout the research process and was more motivated by verbal praise than the treats that were offered daily.

Zachary (Pseudonym)

Zachary was a ten-year-old Caucasian male in the fifth-grade with an ADHD diagnosis. Zachary's parent indicated that he has anxiety in addition to ADHD; however, he does not take any medications for either condition. Zachary's parent also indicated that he regularly listens to self-selected music. Zachary's teacher indicated that he has numerous behavioral issues and gets along with very few peers or teachers. He can become argumentative, as well as verbally and physically aggressive. Zachary was also weak academically in all areas. However, he was highly motivated by the treats offered and completed all phases of the research.

Jacob (Pseudonym)

Jacob was an eleven-year-old Caucasian male in the fifth-grade with an ADHD diagnosis. Jacob's parent indicated that he does not have any comorbid disabilities. The parent also indicated that Jacob does not currently take medication for ADHD and that he occasionally listens to self-selected music. His teacher indicated that he is socially immature and does not have a lot of friends. She also indicated that he often is a follower to others with deviant behaviors and is academically weak. He was also highly motivated to complete the working memory task by the daily treats offered.

Results

For each null hypothesis, a visual analysis was completed to examine the level of performance for each participant in each phase, including any overlapping data that existed between phases, the trend or slope of the data presented for each participant, and variability within and among conditions (Gall et al., 2007, Horner et al., 2005). As recommended by CEC standards of quality, the effect size for each participant was calculated. The Effect size was measured using the Percentage of Non-overlapping Data points (PND), which is calculated based on the number of data points within each phase that overlaps with phase one baseline data (Dunn et al., 2017; Kim & Kimm, 2017; Pyle & Fabiano, 2017). The *p* value was calculated by using Microsoft Excel's formula for binomial distribution probability.

Null Hypotheses

Two null hypotheses were examined based on a visual analysis of the data presented for each participant. At the end of each participant's section, a graph with relevant data to the hypothesis being presented for each participant is included.

Null hypothesis number one (H_01). Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to no music.

Two phases of self-selected music were implemented for each participant, with a baseline phase between the two phases to prevent serial dependency (Byiers et al., 2012).

Melinda – A visual analysis.

Level. Visual examination of the data indicates that working memory under the condition of listening to self-selected music is significantly lower than under the condition of no music present, with no overlapping data points. Also, consistency is evident between the two phases of self-selected music. Baseline data were stable with a downward trend.

Trend. Melinda's baseline data and two phases of self-selected music present had a downward trend. The slope of the data was .57.

Variability. Variability was consistent between the first and second phases of self-selected music. The first phase of self-selected music ranged from 28.44% to 41.80%, and the second phase of self-selected music ranged from 23.86% to 37.92%, with an overall range for self-selected music of 23.86% to 41.80%.

Effect Size. The percentage of non-overlapping data points indicated a very high effect size (PND = 100%, $p < .01$). When compared the overall range for self-selected music of 23.86% to 41.80% to the baseline range of 48.2% to 64.88%, the self-selected music intervention had a very high effect on working memory as measured by the online N-back task, Cognitive Fun! (2008). However, the condition of self-selected music caused a decrease in working memory score rather than an increase.

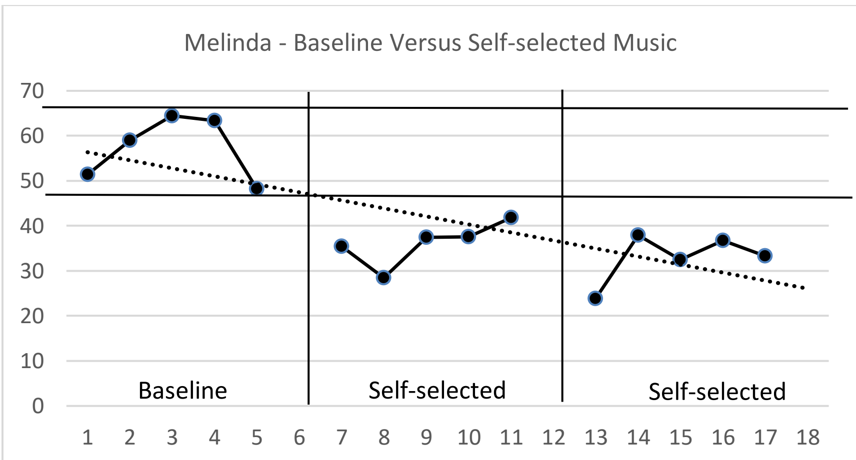

Figure 3. Melinda – baseline versus self-selected music

Stephanie – A visual analysis.

Level. Visual evaluation of Stephanie's baseline data as compared to her two phases of self-selected music indicates that self-selected phases are similar to the baseline data results (figure 4). All self-selected data points overlap with baseline data points except two.

Trend. The trend within Stephanie's baseline data as compared to the two self-selected music phases is a slight downward slope, with a slope of .04.

Variability. The first phase of self-selected music ranged from 22.81% to 47.32%, and the second phase of self-selected music ranged from 19.66% to 38.50%, with an overall range for self-selected music of 19.66% to 47.32%. Consistency is evident between the two phases of self-selected music present.

Effect Size. When compared to the baseline range of 21.71% to 38.00% to the self-selected music overall range of 19.66% to 47.32%, the intervention of self-selected music was an ineffective treatment on working memory as measured by the online N-back task, Cognitive Fun! (2008) (PND = 20%, p < .01).

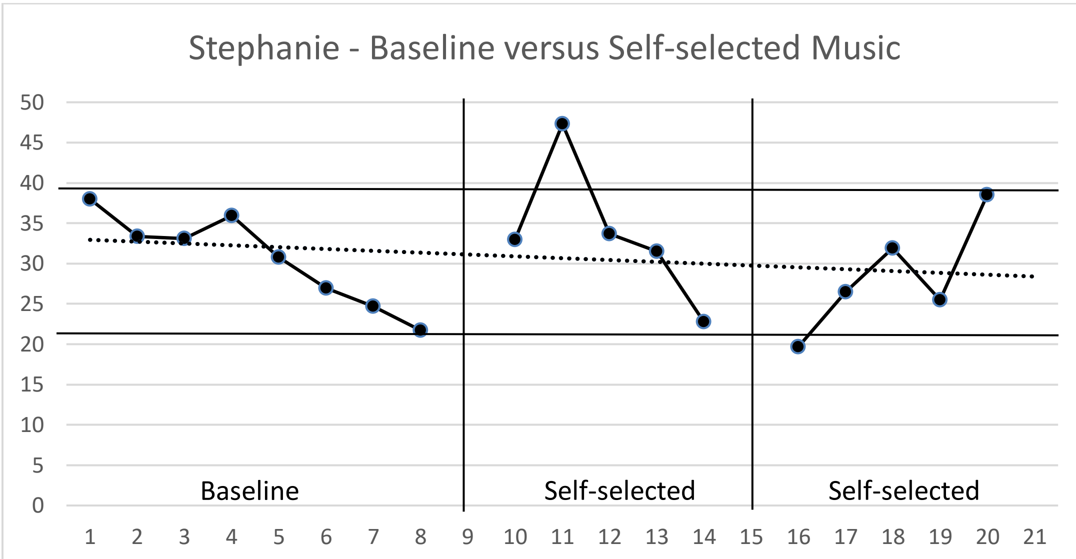

Figure 4. Stephanie – baseline versus self-selected music

Jacob – A visual analysis.

Level. Visual evaluation of Jacob's data indicates that self-selected phases are similar to his baseline data results. All self-selected data points overlap with baseline data points, except two. Also, consistency is evident between the two phases with the condition of self-selected music present.

Trend. The trend of Jacob's baseline data as compared to his self-selected music phases is a slight downward slope, with a slope of .09.

Variability. Jacob's first and second phases of self-selected music were similar in variability. The first phase of self-selected music ranged from 25.15% to 31.96%, and the second phase of self-selected music ranged from 23.17% to 33.54%, with an overall range for self-selected music of 23.17% to 33.54%.

Effect. When comparing Jacob's overall range of self-selected music of 23.17% to 33.54% to the baseline range of 27.57% to 36.55%, the self-selected music intervention was an ineffective treatment on working memory as measured by the online N-back task, Cognitive Fun! (2008) (PND = 20%, p = 0.043945).

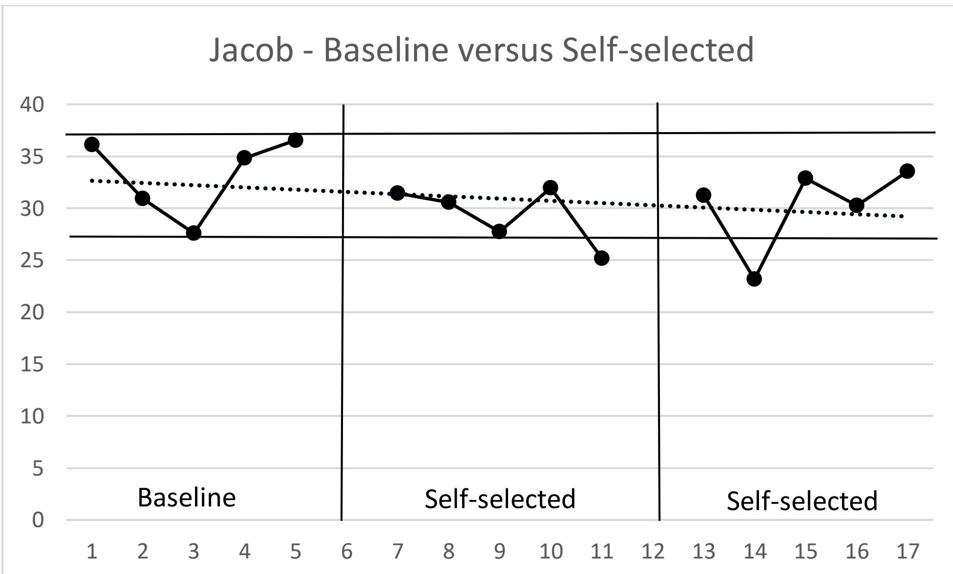

Figure 5. Jacob – baseline versus self-selected music phase

David – A visual analysis.

Level. A visual examination of the data indicates that working memory under the condition of self-selected music is significantly lower than the data collected under the condition of no music present, with no overlapping data points.

Trend. The slope of the data has a downward trend, with a slope of .77.

Variability. The first phase of self-selected music ranged from 32.40% to 39.48%, and the second phase of self-selected music ranged from 20.00% to 38.33%, with an overall range for self-selected music of 20.00% to 39.48%. Consistency is evident between the two phases with the condition of self-selected music present.

Effect. When comparing the overall self-selected music range of 20.00% to 39.48% to the baseline range of 73.33 to 95.00%, the self-selected music was a very effective intervention on working memory as measured by the online N-back task, Cognitive Fun! (2008) (PND = 100% [very high], p < .01). However, the effect that the condition of self-selected music caused a decrease in working memory score rather than an increase.

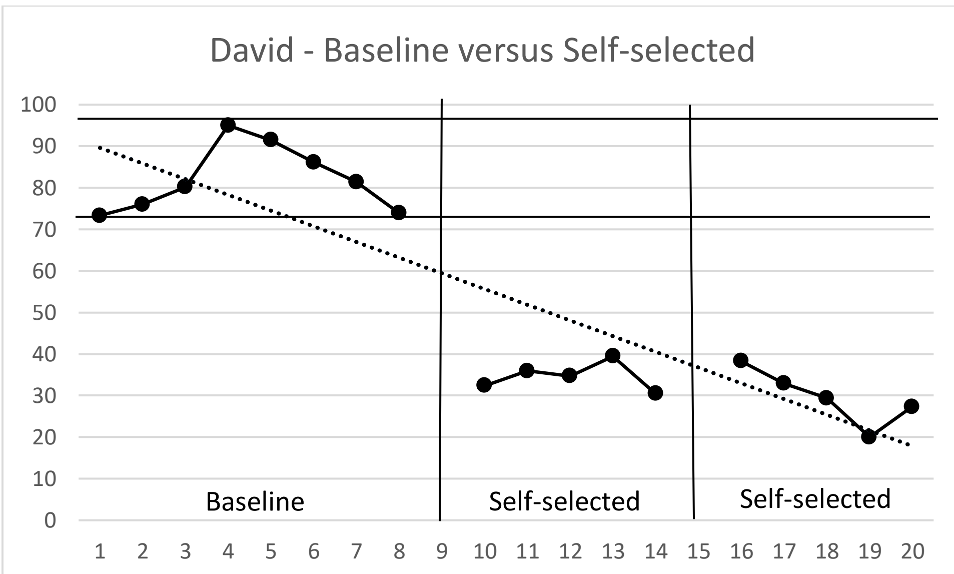

Figure 6. David – Baseline versus Self-selected

Zachary – A visual analysis.

Level. Visual evaluation of the data indicates that self-selected phases are similar to the baseline data results (figure 7). All self-selected data points overlap with baseline data points except one.

Trend. The trend of the data has a slightly downward slope, with a slope of .02.

Variability. The first phase of self-selected music ranged from 25.49% to 39.24%, and the second phase of self-selected music ranged from 24.38% to 48.89%, with an overall range for self-selected music of 24.38% to 48.89%.

Effect. When compared to Zachary's overall range for his two phases of self-selected music of 24.38% to 48.89% to his baseline range of 25.55% to 52.15%, the self-selected music intervention was an ineffective treatment on working memory as measured by the online N-back task, Cognitive Fun! (2008) (PND = 10%, $p < .01$).

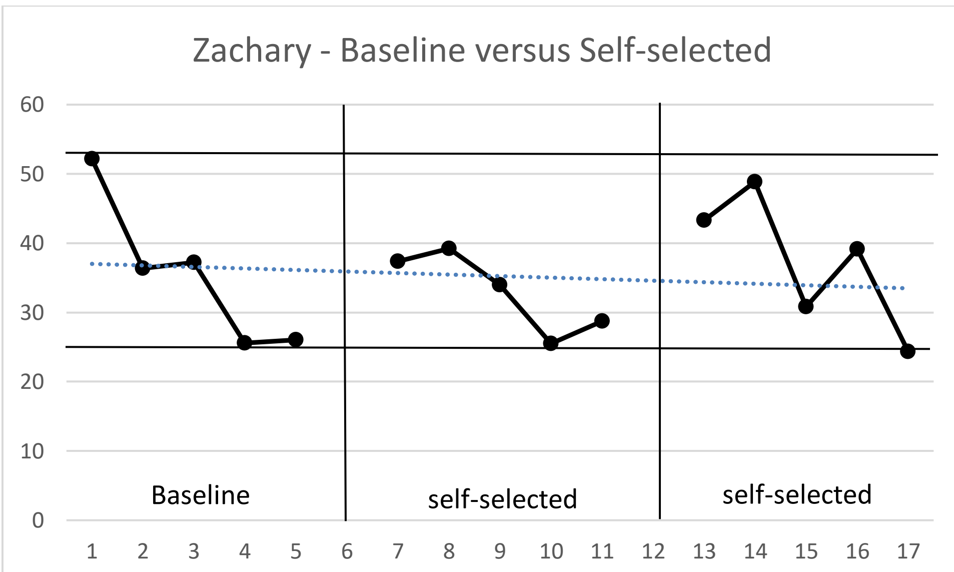

Figure 7. Zachary – Baseline versus Self-selected

Summary of null hypothesis One ($H_0$1). The first null hypothesis was examined through data presented for each participant regarding baseline data compared to two phases each of self-selected music. Overall, the data for three out of five participants indicated no significant change under the condition of self-selected music present. However, two out of five of the participants experienced a decrease in working memory under the condition of self-selected compared to no music present as measured by the online N-back task Cognitive Fun! (2008). None of the participants experienced an increase in working memory under the condition of listing to self-selected music. Therefore, the null hypothesis that working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to no music cannot be rejected.

Table 4

Baseline Compared to Self-selected Music Phases for all Participants

Student	Mean of Baseline	Mean of First Phase of Self-selected	Mean of Second Phase of Self-selected	Effect Size (PND)
David	81.64	34.60	29.60	100%
Melinda	57.29	36.14	32.87	90%
Stephanie	30.56	33.64	28.41	90%
Zachary	35.46	32.96	37.32	10%
Jacob	33.20	29.37	30.22	0%

Null hypothesis number two (H_02) Working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to teacher-selected classical music.

For each participant, after phase one (baseline) data were collected under the condition of no music, one phase of teacher-selected music (Mozart's sonata for two pianos in D major, K488) was followed by two phases of self-selected music. Each phase of the study was separated by one phase of baseline data with an ABACAC design.

Melinda – A visual analysis.

Level. Based on the data presented, Melinda's working memory was most accurate under the baseline condition of no music. She was less distracted by the Mozart music presented than self-selected music. However, she performed best under quiet conditions.

Trend. The trend of the slope is downward, including baseline, teacher-selected music, and self-selected music. The slope of the data is .63.

Variability. The range of teacher-selected music is 39.50% to 54.69%. This is slightly higher than the overall range of self-selected music of 23.86% to 41.80%. However, both teacher-selected and self-selected percentage of accuracy ranges are lower than the baseline range of 48.20% to 64.48%.

Effect size. When comparing the percentage of non-overlapping data points of self-selected music and teacher-selected music, 90% of data points did not overlap with self-selected music, which had a negative impact on working memory (PND = 90%, $p < .01$). However, both types of music decreased working memory.

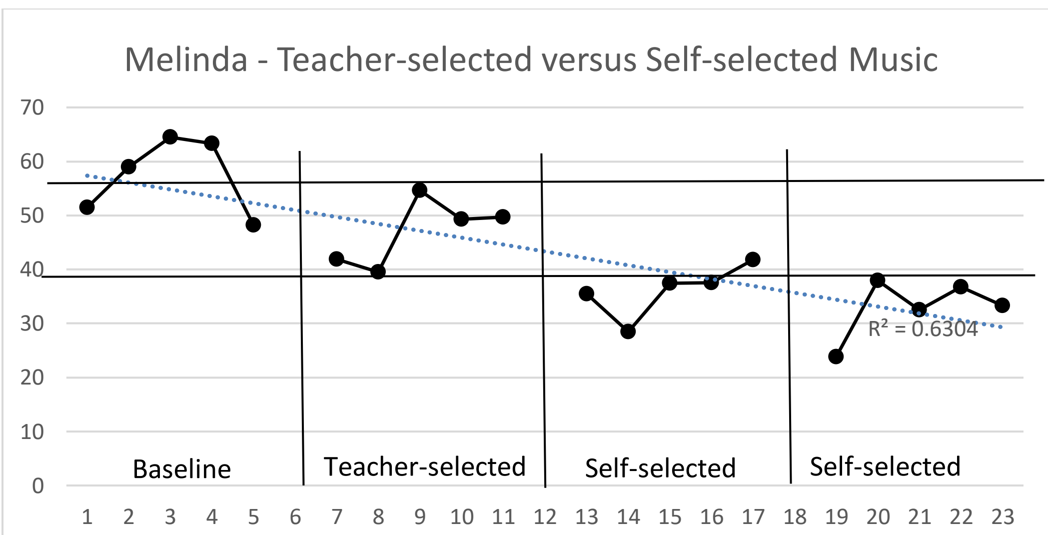

Figure 8. Melinda – Teacher-selected versus Self-selected music

Jacob – A visual analysis.

Level. When comparing achievement between teacher-selected music and student selected music, the visual analysis indicates that working memory as measured by the online N-back task, Cognitive Fun! (2008) shows little variance between teacher-selected music and student-selected music.

Trend. The trend of the data indicates a slightly downward slope of .07.

Variability. The overall range of teacher-selected music phase is 23.25% to 39.09%. When comparing the overall range to the self-selected music overall range of 23.17% to 33.54%, there is no significant difference in the two phases.

Effect Size. The condition of teacher-selected music versus the condition of self-selected music indicates an ineffective treatment and low effect size (PND = 0%, p < .01).

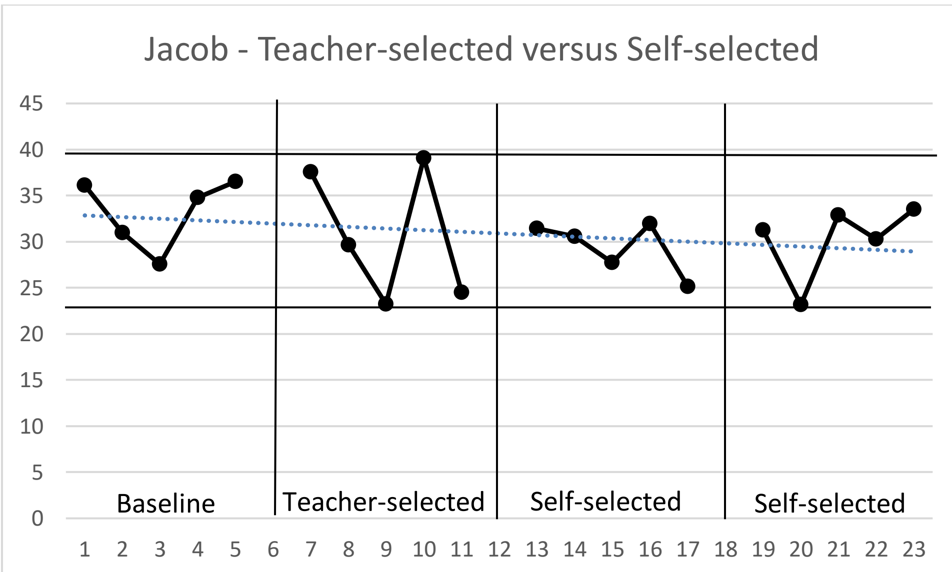

Figure 9. Jacob – Teacher-selected versus Self-selected

Stephanie – A visual analysis.

Level. When comparing achievement between teacher-selected music and student selected music, the visual analysis indicates that working memory as measured by the online N-back task, Cognitive Fun! (2008) is much stronger with the Mozart selection than with the student-selected music.

Trend. The trend of the data is relatively flat, with a slope of less than .01.

Variability. Stephanie's overall range of teacher-selected music is 19.02% to 58.67%, including one outlier datapoint. If the outlier datapoint is excluded from the data, her overall range of teacher-selected music is 47.12% to 58.67%. The overall range of Stephanie's self-selected music phases was 19.67% to 47.32%.

Effect size. When calculating the percentage of non-overlapping data points for effect size, one outlier data point can significantly skew results (Dunn et al., 2017). One outlier data point exists in the teacher-selected phase that reduces the percentage of non-overlapping data points significantly. When including the outlier data point, the difference in the two treatments is ineffective (PND = 0%, p < .01). However, if the outlier datapoint is excluded from evaluation, the condition of teacher-selected music as compared to the condition of self-selected music is very significant (PND = 90%, p < .01). The condition of self-selected music caused a decrease in working memory as compared to teacher-selected music.

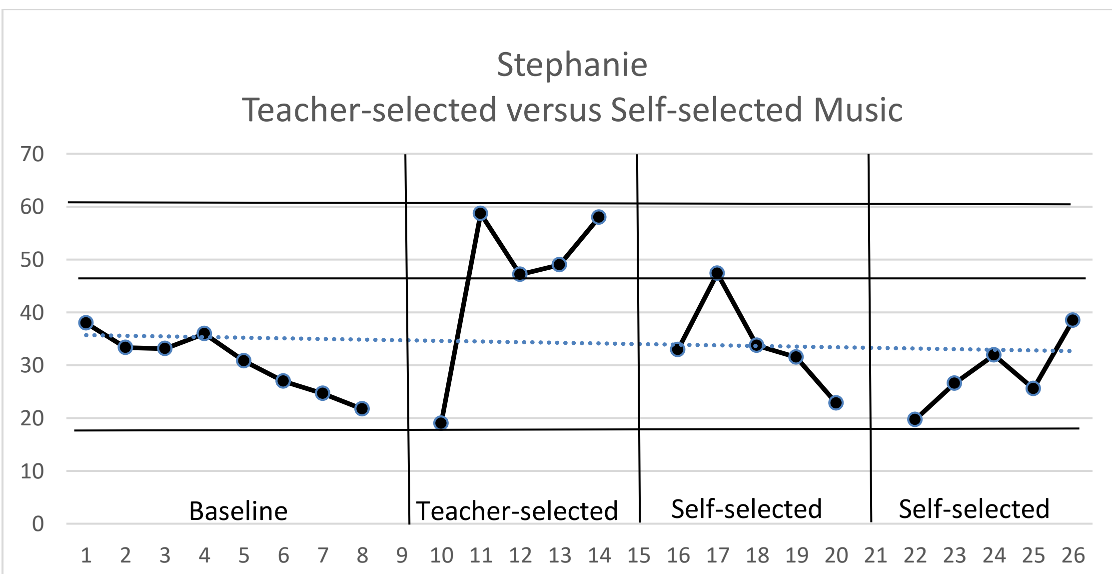

Figure 10. Stephanie - Teacher-selected versus Self-selected Music

David – A visual analysis.

Level. A visual analysis of David's self-selected phases as compared to his teacher-selected music phase indicates that his scores dropped significantly during the self-selected phases, with no data points overlapping between the two conditions.

Trend. The slope for David was .79. This downward trend indicates that David performed best in the baseline phase of no music. However, when comparing self-selected music phases to teacher-selected music phases, David performed lower on self-selected music.

Variability. The overall range of David's teacher-selected music phase was 40.83% to 86.67%, which includes one outlier data point that is much lower than all other data points within the teacher-selected music phase. Even when this outlier datapoint is included in the range, David's overall range of self-selected music falls below his teacher-selected phase, with an overall range of 20.00% to 39.48% accuracy for his self-selected phases.

Effect size. The effect size of self-selected music when compared to teacher-selected and baseline phase is very high (PND = 100%, p <.01). However, the condition of self-selected music present caused a decrease in working memory.

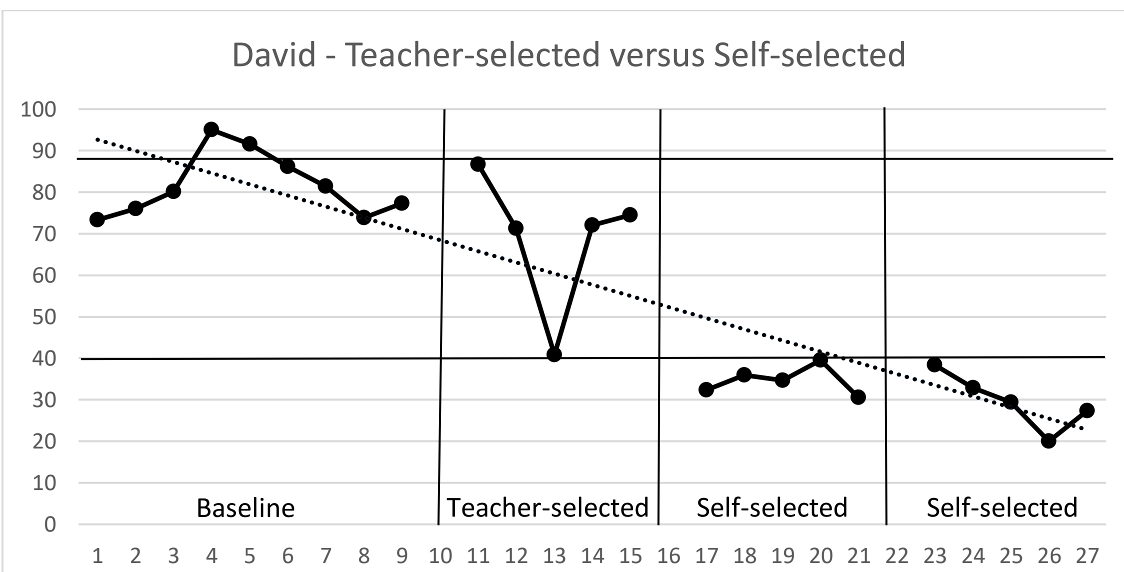

Figure 11. David – Teacher-selected versus Self-selected

Zachary – A visual analysis.

Level. A visual analysis indicated that all phases (baseline, teacher-selected music, and self-selected music) are similar in achievement levels. Each phase had similar ranges of data, with baseline and self-selected music phases dropping slightly lower than teacher-selected music.

Trend. The trendline of Zachary's data has a slight downward slope, with a slope of .02.

Variability. Zachary's achievement levels in his teacher-selected phase range from 33.11% to 50.63%. This is just slightly higher than his overall range in self-selected phases of 24.38% to 48.89%.

Effect size. When comparing Zachary's self-selected phases to his teacher-selected phases, the effect was very low (PND = 40%, p = 0.205078). The effect size of teacher-selected and self-selected music as compared to baseline phase is also very low with all data points overlapping with baseline phase (PND = 0%, $p < .01$).

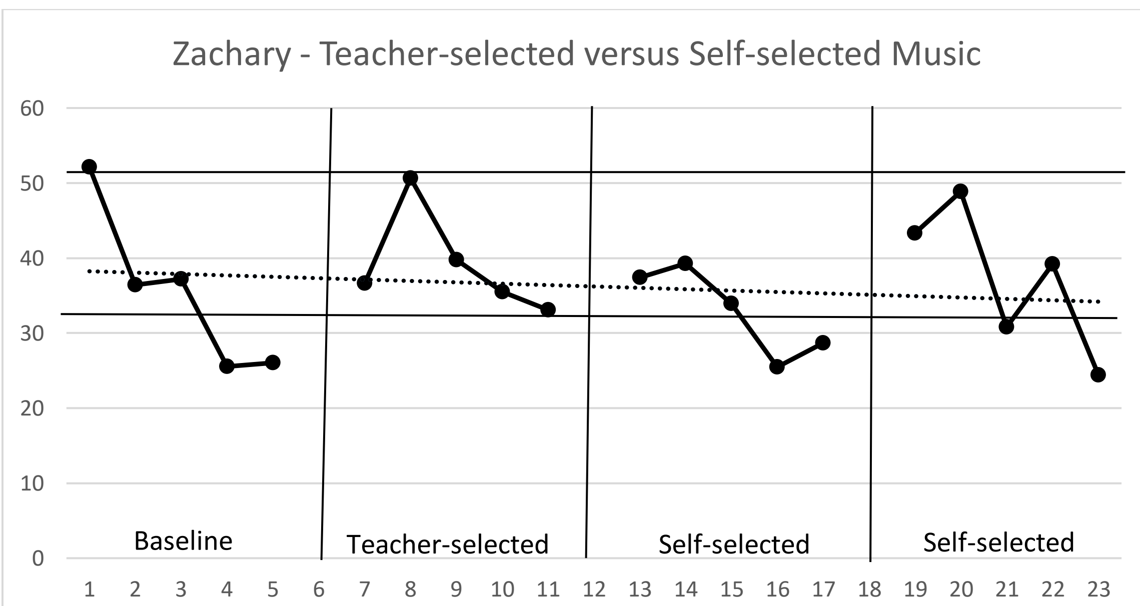

Figure 12. Zachary – Teacher-selected versus Self-selected Music

Summary of null hypothesis two (H_02). When comparing working memory achievement under the conditions of self-selected music and teacher selected music, there was not an increase under the condition of self-selected music. Three participants experienced a decrease in achievement under the condition of self-selected music as compared to teacher-selected music. Two participants did not experience a change under the condition of self-selected music as compared to teacher selected music. Therefore, the null hypothesis that working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to teacher-selected classical music cannot be rejected.

Table 5

Self-selected Music Condition Compared to Teacher-selected music Condition for All Participants

Student	Mean of Baseline	Mean of Teacher-selected	Mean of First Phase of Self-selected	Mean of Second Phase of Self-selected	Effect Size (PND)
David	81.64	69.08	34.60	29.60	100%
Melinda	57.29	47.02	36.14	32.87	100%
Stephanie	30.56	46.36	33.64	28.41	20%
Zachary	35.46	39.13	32.96	37.32	0%
Jacob	33.20	30.82	29.37	30.22	20%

Summary

Two null hypotheses were investigated to determine the answer to the research question, does student-selected music listened to through headphones by fifth-grade students with an ADHD diagnosis increase working memory measured by online N-back tasks, as compared to no music or teacher-selected classical music. The first null hypothesis, working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to no music could not be rejected. Three out of five of the participants had no significant change in working memory during the self-selected music phases. Furthermore, two out of five of the participants experienced a decrease in working memory during the self-selected music phase as compared to the baseline phase of no music.

The second null hypothesis, working memory in students with ADHD will not increase when listening to self-selected music through headphones compared to listening to teacher-selected classical music also could not be rejected. Three participants experienced a decrease in working memory during their self-selected music phases as compared to their teacher selected music phases. Additionally, two out of five of the participants experienced no change in working memory during the self-selected phases as compared to the teacher-selected phases. It is important to note that one student experienced an increase in working memory during her teacher-selected phase as compared to the baseline and self-selected phases. Two additional participants experienced an increase in working memory during the teacher-selected phase as compared to the self-selected music phases. Based on the evidence presented, student-selected music listened to through headphones by fifth-grade students with an ADHD diagnosis does not increase working memory measured by online N-back tasks, as compared to no music or teacher-selected classical music.

CHAPTER FIVE: CONCLUSIONS

Overview

This chapter begins with a discussion of my study, including the purpose of my study and how it relates to the current research surrounding my topic. Then, I discuss the practical implications of my study, including how it is useful for schools, teachers, and parents. This is followed by a discussion of the delimitations and limitations of my research, as well as recommendations for future studies.

Research Question (RQ1)

Does student-selected music listened to through headphones by fifth-grade students with an ADHD diagnosis increase working memory measured by online N-back tasks, as compared to no music or teacher-selected classical music?

Summary of Findings

This research investigated the effects that self-selected music had on the working memory of five fifth-grade students who have ADHD as compared to no music and teacher-selected (classical) music. The evidence presented indicates that the working memory of fifth grade students with ADHD is not increased by listening to self-selected music.

Discussion

The purpose of this study was to determine whether fifth-grade students with ADHD could increase their working memory by listening to self-selected music as compared to no music present or teacher-selected (classical) music present. A convenience sample of five students with ADHD participated in the study. Each participant completed N-back tasks using an online program, Cognitive Fun! (2008) to measure their working memory under the conditions of no music, classical music, and self-selected music.

Theoretical Framework

This research was based on two theories, the Optimal Stimulation theory (Hebb, 1955; Schlosberg, 1954) and the Mozart Effect theory (Rauscher et al.,1993). The Optimal Stimulation theory states that individuals with ADHD need to have an optimal level of stimulation in order to be able to focus, with too much stimulation causing a person to become overwhelmed or too little simulation causing a person to become bored and disengaged (Hebb, 1955; Schlosberg, 1954). The Mozart effect theory states that listening to Mozart music can increase the working memory of individuals (Rauscher, 1993).

Optimal stimulation theory. The optimal stimulation theory (Hebb, 1955; Schlosberg, 1954) states that too much stimulation can cause a distraction for students with ADHD, and not enough stimulation can also cause a decrease in focus and attention. This theory is directly related to this research because the basis of the research was the hypothesis that adding the stimulation of self-selected music would increase the working memory of students with ADHD. This study found that listening to self-selected music had either no effect on the working memory of students with ADHD or it acted as a distractor cause the working memory to decrease under the condition of self-selected music. However, when students with ADHD listened to classical music during the working memory N-back tasks, for some students their working memory increased. This finding supports the optimal stimulation theory and the Mozart effect theory (Rauscher et al., 1993).

Mozart effect theory. The Mozart effect states that working memory increases when listening to Mozart music (Rauscher et al., 1993). This theory was based upon a study that showed an increase in working memory under the condition of listening to Mozart music. The same Mozart composition that was used in the original 1993 study (Mozart's sonata for two pianos in D major, K488) was used for the purposes of this research. Two out of five participants in this research study experienced improvement under the condition of listening to Mozart music. The remaining three participants did not experience a change between their baseline phase of no music and the condition of Mozart music present.

Background music in educational settings. Studies have shown that playing background music may help to reduce some behaviors that would be a barrier to academic success (Desrochers et al., 2014; Yen-Nig et al., 2016; Ziv & Doley, 2013). In these studies, music that was perceived to be soothing or calming was played in the background of academic settings (Desrochers et al., 2014; Yen-Nig et al., 2016; Ziv & Doley, 2013). Music has also been shown to help students with ADHD to focus during classroom activities (Chew, 2010; Reif, 2016). The current study supports this theory in that two of the students increased working memory under the condition of listening to Mozart music. However, the effect could have been based on the individual's perspective of whether the music was perceived as soothing (Perlovsky et al., 2013). None of the participants experienced an increase in working memory while listening to self-selected music.

Some studies have also indicated that playing music in the background of academic settings can be more of a distractor than a benefit (Bloor, 2009; Patson & Tippett, 2011; Tze & Chou, 2010). This research supports this theory since none of the students experienced an increase in working memory when listening to self-selected music as compared to no music or teacher-selected classical music. Bloor (2009) found that background music improved scores in the area of reading but not in math. Tze & Chou (2010) compared reading comprehension data of normally developing students under the conditions of no music playing in the background, hip-hop music playing in the background, and classical music playing in the background.

Results of the comparison indicated that students performed best under quiet conditions (Tze & Chou, 2010). The current research supports the theory that music can be more of a distractor. Two out of five participants experienced a decrease in working memory under the condition of self-selected music. The remaining three participants experienced no change from their baseline data of no music. However, two students experienced an increase in working memory under the condition of Mozart music.

Self-selected music. According to research, when students can select their own music, they may have a greater effect from the music (Cassity et al., 2007; Liljestrom et al., 2012; McFerran et al., 2015). The familiarity of the music may have a positive effect on emotions (Cassity et al., 2007; Liljestrom et al., 2012). Research also indicates that there may be a memory-based mechanism that effects emotions (Liljestrom et al., 2012). The current research contradicts these finding based on the fact that when students chose their own music, their working memory either decreased or remained the same.

Self-selected music and subject areas. Chew (2010) conducted a study regarding the effects of classical music, television noise, silence, and popular music as background noise during an academic task for students with ADHD. Chew (2010) found that the students performed best under the condition of popular music they enjoyed. The current study contradicts this study because each participant was able to choose their own music during the self-selected music phases. Each child's selection of music was downloaded to individual MP3 players, and they were able to listen to their self-selected music through headphones while participating in the working memory N-back task. Under the condition of self-selected music, two students' scores decreased, and the other three remained consistent with baseline (no music) working memory scores, while two out of five participants increased their working memory under the condition of teacher-selected music. This may be indicative that students do not always select music that increases working memory.

Several studies indicate that math scores or the number of math problems being completed can increase under the condition of background music playing during math assessments (An & Tillman, 2015; Hallam & Price, 1998; Kesan et al., 2012; Taylor & Rowe, 2012; Zentall et al., 2012). Hallam & Price (1998) found that the number of completed math problems increased when background music was played in the background. Additionally, in a review of two studies, Hallam et al. (2002) concluded that calming music resulted in better math performance. Taylor and Rowe (2012) also found that math achievement increased under the condition of Mozart music playing in the background. All of these studies used music that was perceived as pleasant. The current study supports the possibility of higher achievement under the condition of pleasant music, as two students increased working memory under the condition of listening to Mozart music; however, the current study does not support the theory when one considers that the condition of self-selected music did not result in an increase in working memory. Each participant was asked what music they enjoy, and that music was placed on their individual MP3 players. This may be indicative that fifth-grade students often do not select music that is helpful to their working memory capacity.

Classical music versus student-selected music. Research indicates that music that is perceived as calming can improve the emotional state of a person, including music that was self-selected (Labbe et al., 2007). Several studies indicate that self-selected music may be just as effective to increase memory and learning as classical music (Cassity et al., 2007; Liljestrom et al., 2012). The current study contradicts this idea based on the results of higher working memory for some students under the condition of Mozart music and a decrease for some students under the condition of self-selected music. No student in the current study increased working memory under the condition of self-selected music, and no student decreased working memory under the condition of Mozart music present.

Music's effect on mood. Listening to various types of music can affect emotions for individuals (Mattar, 2013). While pleasant music can have a calming effect (Mattar, 2013; Nguyen & Grahn, 2017), it can also negatively affect emotions (Nguyen & Grahn, 2017). Listening to Mozart music may help students to relax and feel less anxious, which can improve learning (Mattar, 2013; North et al., 2004; Pelayo, 2014; Waugh & Riddoch, 2007; Yen-Ning et al., 2016). McFerran et al. (2015) conducted a study that used self-selected music and found that students who were mentally healthy chose music that did have a positive effect on their emotional state. However, McFerran et al. (2015) also found that students who were experiencing sadness or depression self-selected music that was associated with anger. In the current study, students were allowed to self-select music. When their chosen music was played, working memory either decreased or remained the same for each participant. However, when classical music was presented, two of the participants increased working memory. It is feasible that the effects on working memory may have had more to do with a calming effect or other emotional response to the music.

Background music for students with ADHD. A review of the literature indicated that students with ADHD may benefit from music perceived as pleasant playing in the background, whether it be classical music or other music that students enjoy (Pelham et al., 2011; Verrusio et al., 2015; Zentall et al., 2012). One study even found that rock music played in the background increased on-task behaviors and social functioning when the music was perceived as pleasant by the listener with ADHD (Cripe, 1986). Pelham et al. (2011) found that background music helped students with ADHD to remain focused. The current study contradicts these findings based on the results. While two students showed an increase in working memory under the condition of Mozart music, all five participants either decreased or stayed the same as baseline (no music) under the condition of self-selected music.

Implications

As with all students with special needs, each individual is unique, including the participants in this study. That being considered, the results of the data cannot be generalized to any population based on the uniqueness of each child with disabilities. Each child's responses to both self-selected and classical music are unique. The results of this study indicate that children are affected differently with different types of music. The data in this study indicates that there may be a much stronger response for some children when presented with classical music. It also shows that, when given the opportunity to choose for themselves, children may not be making the best selections of music that can help them with their working memory ability, which includes focus and attention.

Overall, the children in this study performed the greatest under the condition of no music. However, two children improved under the condition of Mozart music, and all of the children performed at the same or at a reduced rate under the condition of self-selected music. Based on the results of classical music having a higher rate of improvement on the working memory of students with ADHD, it may follow that the music that these students selected was music that they enjoyed but not the best music for their ability to increase working memory. As indicated with learning style preferences research, the preferences of an individual may not always dictate the best manner in which information can be learned and retained (Kirschner, 2016). The way that a person prefers to learn may not lead to an actual increase in information retained

(Kirschner, 2016). As is evident in the current research, this may be true also of the music that one prefers. Concentration is highly correlated with one's interest in the subject matter rather than learning styles (Li & Yang, 2016; Moser, & Zumbach, 2018). Research indicates that a person's preferred learning style (visual, auditory, kinesthetic, etc.) is not necessarily always the best mode for learning various types of material (Kirschner, 2016; Li & Yang, 2016; Moser & Zumbach, 2018; Willingham, Hughes, & Dobolyi, 2015; Li & Yang, 2016). Just as one's learning preference may not be the best way to learn all materials, also a fifth-grade student's music preference may not be the best for helping with focus and learning.

Parents and teachers who are interested in learning more about their child or student could conduct their own individual single-subject design studies. The online N-back task Cognitive Fun! (2008) could be used, or other N-back tasks are available. This is a simple working memory task that can help individuals understand their own unique ability to focus or become distracted by various types of music. This could help them to determine whether their children/students might improve their working memory while listening to various types of music. Some children may be able to increase working memory while listening to classical music. Some may even show improvement with self-selected music, even though the five participants in this study did not. This is highly individualized research that cannot be generalized to any population.

Delimitations and Limitations

This study only included participants who were in the fifth grade. This population was chosen based on access to these students and teacher cooperation. The research assistant for this project was a fifth-grade teacher who was extremely reliable and committed to seeing this project through to the end. Additionally, the teacher-selected music that was chosen was limited to one selection, Mozart's sonata for two pianos in D major, K488, which was played through headphones during the teacher-selected music phase. The self-selected music was limited to non-explicit music to comply with school appropriateness and parental expectations.

Several limitations are noted, including limitations with the population of participants, music selections, and setting.

Population

This research was limited in that it only included five participants. Additionally, while the population of participants included two girls and three boys, the population in this convenience sample were all fifth-grade students, and the sample lacked diversity.

Music selections

When requesting their self-selected music, four out of five of the students requested rap music. It was necessary to locate clean versions of their requested music in order to be school appropriate and meet parental expectations.

Setting

Each student participating in the on-line N-back task on their school-issued Chromebook with headphones on during music phases. However, some threats to internal and external validity existed due to the fact that students with ADHD are easily distracted by the other participating students entering the room, their own chattiness, and setting up their Chromebooks on a daily basis. The young age of the participants was also a factor, as the immaturity of the students, along with their diagnosis of ADHD, were all contributors to a very distractible group of students.

Recommendations for Future Research

Conducting similar research with an older population who would have their own preferred music more readily available than these fifth-grade students may have different results. I have witnessed high school aged students using headphones during academic activities who were quiet and appeared to be more focused on their work. However, more information is needed to realize whether they were actually performing better academically or if their quiet demeanor was for another reason. Replicating this study with an older set of students could possibly help to answer some of the possible factors that may confound the research. Another question that remains unanswered is whether students are able to choose music that is best for increasing working memory. This study provided some evidence that working memory increased under the condition of classical music. Further research in this area is necessary to determine if Mozart music can increase working memory for students with ADHD.

Additionally, this study focused on only students with ADHD. Further research would be necessary to determine if self-selected music or classical music might affect the working memory of students with other disabilities or students with no disabilities. However, caution should be applied when making any generalized statements regarding how music affects a population of people. While music may be found to affect a person's working memory in some way, the finding is unique to the individual.

Furthermore, during the no music phases of the study, noise cancelling headphones were not used. Different results may have been obtained had noise cancelling headphones been used. Additionally, it is difficult to note whether the results during music listening phases were based on the music itself or the fact that other distracting elements were blocked out by the music.

Future studies might consider adding a phase that includes noise cancelling headphones or white noise.

Motivation was another factor in this research that may require further research. Throughout data collection, students were able to pick an item from a treasure box each time they participated. Some students were highly motivated by a trip to the treasure box, and others were not. Additionally, MP3 players were used for all music phases for this research. During phase one (baseline – no music), the students were highly motivated to get through the baseline phase so that they could begin using the MP3 players. One might consider whether this extra motivation to get to the next phase had an effect on their working memory scores during phase one (no music). Additionally, the students were each promised that if they fully completed all phases of the research, that they would be allowed to keep their MP3 players once they were done. While this motivated each participant to see the data collection process through to the end, one may consider whether removing this type of motivation would have affected the working memory scores.

Summary

This research found that the working memory of five fifth-grade students did not increase under the condition of self-selected music as measured by an online N-back task, as compared to no music present and teacher-selected (classical) music present. One student experienced an increase in working memory under the condition of teacher-selected music as compared to no music and self-selected music, and two students experienced an increase in working memory under the condition of teacher-selected music as compared to the self-selected phases only. Students with ADHD are unique individuals, and this research cannot be generalized to any population. It is important to note that these fifth-grade students chose music that was popular and familiar to them. However, they may not have made the best choices based on what music would be the most helpful to them while completing working memory N-back tasks. This project provides many opportunities for future research, but caution is recommended against generalizing any findings to populations due to the individualized nature of this research.

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APPENDIX A

Record of Research Session

Date: ____________________________

Facilitator(s) of Session: ____

Attending Research Session Participants:

____

____

____

____

____

____

____

____

____

If a research participant did not participate, note why:

____

____

Note any distractions that occurred during research session:

____

____

APPENDIX B

January 15, 2018

Jennifer R. Ramey
12920 Bundle Road
Chesterfield, VA 23838

Dear Mrs. Ramey:

After careful review of your research proposal entitled "A Single-subject Study on Listening to Student-selected Music through Headphones for Students with ADHD," I have decided to grant you permission to conduct your study at XXXXX County Middle School.

Check the following boxes, as applicable:

☐ Data will be provided to the researcher stripped of any identifying information.

☐ I/We are requesting a copy of the results upon study completion and/or publication.

Sincerely,

Dr. XXX XXXXXXX
Superintendent
XXXXX County Public Schools

APPENDIX C

The Liberty University Institutional
Review Board has approved this document for use from
10/24/2018 to 10/23/2019
Protocol # 3486.102418

PARENT/GUARDIAN CONSENT FORM

A SINGLE-SUBJECT STUDY ON LISTENING TO STUDENT-SELECTED MUSIC THROUGH HEADPHONES FOR STUDENTS WITH ADHD

Jennifer Renee Royster Ramey
Liberty University
School of Education

Your child is invited to be in a research study of how listening to self-selected music affects the working memory of students with ADHD. He or she was selected as a possible participant because of his or her special education identification as a child with ADHD and because he or she is a fifth or sixth grade student. Please read this form and ask any questions you may have before agreeing to allow your child to be in the study.

Jennifer R. Ramey, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine whether listening to self-selected music through head phones by students with an ADHD diagnosis increases working memory, as compared to no music or teacher-selected classical music.

Procedures: If you agree to allow your child to be in this study, I would ask him or her to do the following things:

- A demographic questionnaire will be sent home for you to complete regarding your child. This information will be kept confidential. It will include questions such as age, gender, other disabilities present, medications, and music listening habits of your child.
- I will meet with your child to familiarize them with music listening devices and ensure they are comfortable with selecting their own music.
- I will meet with your child to train them on how to use the online N-back task and ensure they are comfortable with the program.
- Your child will be asked to log onto an online computer program (Cognitive Fun!) and participate in a series of on-line working memory tasks under the conditions of no music present, listening to their own chosen music through headphones, and listening to classical music selected by the researcher through headphones. For each task, your child will watch a series of pictures and press a key when he or she sees the same image from two images ago. Each session will last approximately 20-30 minutes, and there will be approximately 30 sessions over the course of 10 weeks. These sessions will not interfere with academic instruction, and a schedule will be created based on his or her availability and schedule.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: Participants may gain self-awareness of their own ability to concentrate while listening to various types of music. Benefits to society include adding to empirical knowledge of specific strategies to assist students with ADHD diagnoses to be academically successful.

Review Board has approved this document for use from
10/24/2018 to 10/23/2019
Protocol # 3486.102418

Compensation: Your child will not be compensated monetarily for participating in this study. However, your child will be allowed to select an item out of a treasure box upon completion of each session. The treasure box will include items such as small toys or edible items.

Confidentiality: The records of this study will be kept private. In any sort of report that I might publish, I will not include any information that will make it possible to identify a subject. Pseudonyms will be used in any published reports to conceal your child's identity. Research records will be stored securely, and only the researcher will have access to the records. All documentation of the sessions and data collected will be kept in a locked and secure location at all times. All electronic data will be password protected at all times. All records will be destroyed after three years. No recordings, either visual or auditory, will be made of the research sessions.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with Liberty University or Amelia County Public Schools. If you decide to allow your child to participate, he or she is free to withdraw at any time without affecting those relationships.

How to Withdraw from the Study: If your child chooses to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should your child choose to withdraw, any data collected will be destroyed immediately and will not be included in this study.

Contacts and Questions: The researcher conducting this study is Jennifer Ramey. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at jramey5@liberty.edu or (804) 314-6191. You may also contact the researcher's faculty advisor, Dr. Elizabeth Hillman, at ehillman2@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to allow my child to participate in the study.

(NOTE: DO NOT AGREE TO ALLOW YOUR CHILD TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

____

Signature of Parent Date

____

Signature of Investigator Date

APPENDIX D

Date

Dear Parent/Guardian:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. I am interested in researching specific strategies that may assist students with ADHD diagnoses to perform better academically. Specifically, the purpose of my research is to determine the effect of listening to student-selected music on the working memory of students with ADHD, and I am writing to invite your child to participate in my study.

If you are willing to allow your child to participate, he or she will be asked to participate in an online working memory game while listening to self-selected music, teacher-selected music (classical), and no music. These sessions will be held over a period of several weeks during the regular school day; however, students will not miss academic instruction in order to participate in the study. It should take approximately 20 minutes per session for your child to complete the procedures listed. Your child's participation will be completely anonymous, and no personal, identifying information will be collected. For your child to participate, please complete and return the consent document to your child's teacher. I will not be provided any information regarding your child without your explicit permission to the school system.

A consent document is attached to this letter and contains additional information about my research. Please sign the consent document and return it to your child's teacher.

Sincerely,

Jennifer R. Ramey, EdS

APPENDIX E

PARENT/GUARDIAN CONSENT FORM

A SINGLE-SUBJECT STUDY ON LISTENING TO STUDENT-SELECTED MUSIC THROUGH HEADPHONES FOR STUDENTS WITH ADHD

Jennifer Renee Royster Ramey
Liberty University
School of Education

Your child is invited to be in a research study of how listening to self-selected music affects the working memory of students with ADHD. He or she was selected as a possible participant because of his or her special education identification as a child with ADHD and a middle school student. Please read this form and ask any questions you may have before agreeing to allow your child to be in the study.

Jennifer R. Ramey, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine whether listening to self-selected music through headphones by students with an ADHD diagnosis increases working memory, as compared to no music or teacher-selected classical music.

Procedures: If you agree to allow your child to be in this study, I would ask him or her to do the following things:

> Your child will be asked to participate in a series of online working memory tasks under the conditions of no music present, while listening to their own chosen music through headphones, and while listening to classical music selected by the researcher through headphones. There will be a total of six sessions, and each session will be no longer than approximately 20 minutes each. Additionally, these sessions will not interfere with academic instruction.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: Participants may enjoy the sessions and may gain self-awareness of their own ability to concentrate while listening to various types of music. Benefits to society include adding to empirical knowledge of specific strategies to assist students with ADHD diagnosis to be successful academically.

Compensation: Your child will not be compensated monetarily for participating in this study. However, your child will be allowed to select an item out of a treat basket upon completion of each session. The treat basket will include items such as small toys or edible items.

Confidentiality: The records of this study will be kept private. In any sort of report that I might publish, I will not include any information that will make it possible to identify a subject.

Research records will be stored securely, and only the researcher will have access to the records. All documentation of the sessions and data collected will be kept in a locked and secure location at all times. All electronic data will be password protected at all times. All records will be destroyed after three years. No recordings, either visual or auditory, will be made of the research sessions.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with Liberty University or XXXX Public Schools. If you decide to allow your child to participate, he or she is free to withdraw at any time.

How to Withdraw from the Study:

If your child chooses to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should your child choose to withdraw, any data collected will be destroyed immediately and will not be included in this study.

Contacts and Questions: The researcher conducting this study is Jennifer Ramey. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at jramey5@liberty.edu or (804) 314-6191. You may also contact the researcher's faculty advisor, Dr. Elgen Hillman, at hillmane@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall 1887, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to allow my child to participate in the study.

(NOTE: DO NOT AGREE TO ALLOW YOUR CHILD TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

____

Signature of Parent Date

____

Signature of Investigator Date

APPENDIX F

ASSENT OF CHILD TO PARTICIPATE IN A RESEARCH STUDY

What is the name of the study and who is doing the study?
"A Single-subject Study on Listening to Student-selected Music Through Headphones for Students with ADHD" by Jennifer R. Ramey

Why are we doing this study?
We are interested in studying whether listening to self-selected music may have an effect on the memory of students with ADHD.

Why are we asking you to be in this study?
You are being asked to be in this research study because you have a diagnosis of ADHD and we are interested in seeing the effects of music on the memory of students with ADHD.

If you agree, what will happen?
If you are in this study, you will be asked to participate in a working memory task over six sessions that will last about 20 minutes each. You will not be pulled from your regular classes to participate. Instead, you will participate during your pride time or other non-academic times during your day. You will perform an online working memory task while listening to no music, self-selected music, and teacher-selected music (classical).

Do you have to be in this study?
No, you do not have to be in this study. If you want to be in this study, then tell the researcher. If you don't want to, it's OK to say no. The researcher will not be angry. You can say yes now and change your mind later. It's up to you.

Do you have any questions?
You can ask questions any time. You can ask now. You can ask later. You can talk to the researcher. If you do not understand something, please ask the researcher to explain it to you again.

Signing your name below means that you want to be in the study.

____
Signature of Child　　　　　　　　　　　　　　　　　　　　Date

Jennifer R. Ramey
Jramey5@liberty.edu
Dr. Elgen Hillman
Hillmane@liberty.edu

Liberty University Institutional Review Board,
1971 University Blvd, Green Hall 1887, Lynchburg, VA 24515
or email at irb@liberty.edu.

APPENDIX G

Parent Questionnaire

Thank you for agreeing to allow your child to participate in this research process. For data collection purposes only, please answer the following short survey. All information obtained will remain confidential, and any identifying information will be removed prior to reporting. This form, along with all other data collected for the purposes of this research, will be stored in a locked and secure area and be destroyed after a waiting period of three years.

Name of Student: ___________________________________ Male / Female (circle one)

Age: ____________ Grade: _____________ Repeated Grade (If Applicable): _________

1. Is your child currently taking medication for his/her ADHD?
   Yes / No (Circle One)

   If yes, what is the name of the medication and dosage (not required for participation).
   ____
   ____
   ____

2. Will you allow your child to bring a personal music playing device with their choice of music to school on days when self-selected music is being collected (not required for participation)?

   Yes / No (Circle One)

   Additional Comments:
   ____
   ____
   ____

3. Does your child regularly self-select and listen to music?

4. Yes / No (Circle One)

5. Additional Comments:
   ____
   ____
   ____

6. Do you wish to monitor/approve of the music that your child selects?

   Yes / No (Circle One)

   Additional Comments:

   ____

   ____

   ____

APPENDIX H

Username/Password Sheet

Name: ____

Username: number1 **Password:** number1

Name: ____

Username: number2 **Password:** number2

Name: ____

Username: number3 **Password:** number3

Name: ____

Username: number4 **Password:** number4

Name: ____

Username: number5 **Password:** number5

Name: ____

Username: number6 **Password:** number6

Name: ____

Username: number7 **Password:** number7

Name: ____

Username: number8 **Password**: number8

APPENDIX I

Scripts

First Session - Baseline (A)

Please say the words in red. Instructions are in black.

You will be participating in an N-back task that is designed to measure your working memory ability. Today, you will not be listening to music during your task. On your computer screen you will see the Cognitive Fun! website. On the upper righthand side of the website you should see a place for you to enter your username and password. I will give you your username and password now. Do not do anything until I tell you to do so.

(Pause to pass out usernames and passwords.)

Please enter your username and password and click on login.

(Pause to allow time to log in.)

To ensure that you are at the right test, please click on "Tests" then "Memory."

Now, scroll down to the third item entitled "Working Memory Test (N-back)."

Pause to ensure that all students are on the correct test.

Please click on "click here for a demonstration, and follow the directions on your screen.

Pause to allow time for students to see the demonstration. Circulate around the room to ensure that all of the students understand the demonstration. Allow the student to view the demonstration multiple times if needed.

When I am done reading the directions, you will click on the blue "click here to start" button. Click on the pictures you saw 2-back, just like in the demonstration. When you see the red "Results now available" stop the test by clicking on the red words. Then, click on the blue "return to test" button. Please complete five tries, and then raise your hand. If you have a question during testing, please wait until after you click on the "results now available" red button, and raise your hand quietly to ask your question. You may begin.

If this is their first baseline session, more than five sessions will probably be necessary. Check their statistics for stability of baseline data. If it has not been established, have the student complete five more tries and check their data again. Stability of the baseline data is established when they have received three similar scores in a row.

Thank you for participating. Please select and item from the treat basket, and return to your regular schedule.

Subsequent A Sessions

Please say the words in red. Instructions are in black.

You will be participating in an N-back task that is designed to measure your working memory ability. Today, you will not be listening to music during your task. On your computer screen you will see the Cognitive Fun! website. On the upper righthand side of the website you should see a place for you to enter your username and password. I will give you your username and password now. Do not do anything until I tell you to do so.

(Pause to pass out usernames and passwords.)

Please enter your username and password and click on login.

(Pause to allow time to log in.)

To ensure that you are at the right test, please click on "Tests" then "Memory."

Now, scroll down to the third item entitled "Working Memory Test (N-back)."

Pause to ensure that all students are on the correct test.

When I am done reading the directions, you will click on the blue "click here to start" button. Remember to click on the pictures you saw 2-back, and when you see the red "Results now available" stop the test by clicking on the red words. Then, click on the blue "return to test" button. Please complete five tries, and then raise your hand. If you have a question during testing, please wait until after you click on the "results now available" red button, and raise your hand quietly to ask your question. You may begin.

Thank you for participating. Please select and item from the treat basket, and return to your regular schedule.

Classical Music (B)

Please say the words in red. Instructions are in black.

You will be participating in an N-back task that is designed to measure your working memory ability.

On your computer screen you will see the Cognitive Fun! website. On the upper righthand side of the website you should see a place for you to enter your username and password. I will give you your username and password now. Do not do anything until I tell you to do so.

(Pause to pass out usernames and passwords.)

Please enter your username and password and click on login.

(Pause to allow time to log in.)

To ensure that you are at the right test, please click on "Tests" then "Memory."

Now, scroll down to the third item entitled "Working Memory Test (N-back)."

Pause to ensure that all students are on the correct test.

If you wish to see the demonstration, please click on "click here" for a demonstration, and follow the directions on your screen.

Pause to allow time for students to see the demonstration. Circulate around the room to ensure that all of the students understand the demonstration. Allow the student to view the demonstration multiple times if needed.

Today, you will be listening to classical music during your task. You should each have a set of headphones, and a musical piece is saved onto your computer. Before you begin your N-back task, please put on your headphones and click on the music to ensure it begins playing. Raise your hand if there is a problem with your music. Please test your music now.

Pause to allow time for the students to try their music.

When I am done reading the directions, you will click on the blue "click here to start" button. Remember that you are clicking on the picture that you saw two times back, and when you see the red "Results now available" stop the test by clicking on the red words. Then, click on the blue "return to test" button. Please complete five tries, and then raise your hand. If you have a question during testing, please wait until after you click on the "results now available" red button, and raise your hand quietly to ask your question. You may begin.

Pause to allow time for the students to complete five tries of the N-back task.

Thank you for participating. Please select and item from the treat basket, and return to your regular schedule.

Self-selected Music (C)

Please say the words in red. Instructions are in black.

You will be participating in an N-back task that is designed to measure your working memory ability.

On your computer screen you will see the Cognitive Fun! website. On the upper righthand side of the website you should see a place for you to enter your username and password. I

will give you your username and password now. Do not do anything until I tell you to do so.

(Pause to pass out usernames and passwords.)

Please enter your username and password and click on login.

(Pause to allow time to log in.)

To ensure that you are at the right test, please click on "Tests" then "Memory."

Now, scroll down to the third item entitled "Working Memory Test (N-back)."

Pause to ensure that all students are on the correct test.

Today, you will be listening to your self-selected music during your task. Before you begin your N-back task, please put on your headphones and click on the music to ensure it begins playing. Raise your hand if there is a problem with your music. Please test your music now.

Pause to allow time for the students to try their music.

When I am done reading the directions, you will click on the blue "click here to start" button. Remember that you are clicking on the picture that you saw two times back, and when you see the red "Results now available" stop the test by clicking on the red words. Then, click on the blue "return to test" button. Please complete five tries, and then raise your hand. If you have a question during testing, please wait until after you click on the "results now available" red button, and raise your hand quietly to ask your question. You may begin.

Pause to allow time for the students to complete five tries of the N-back task.

Thank you for participating. Please select and item from the treat basket, and return to your regular schedule.