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THE EFFECT OF AUDITORY STIMULI ON TEST PERFORMANCE: TESTING THE AROUSAL HYPOTHESIS

by

Ian Thomas Kells

A thesis submitted to the Graduate College
in partial fulfillment of the requirements
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THE EFFECT OF AUDITORY STIMULI ON TEST PERFORMANCE: TESTING THE AROUSAL HYPOTHESIS

Ian Thomas Kells, M.M.

Western Michigan University, 2017

Since the publication of Rauscher, Shaw, and Ky's study in 1993 on the "Mozart Effect", the study of music and its effect on cognition and performance has gained significant attention. Roth and Smith (2008) investigated this "Mozart Effect" and suggested a continuation of research and interpretation through an arousal theory. This study examined the effects of a subject-identified arousing stimulus on performance on the Verbal Reasoning portion of the GRE, analyzed through an arousal theory framework. A sample of 24 non-music Western Michigan University students took part in one 60-minute testing period using subject-preferred music, which was then analyzed across four time blocks. Music was administered in three time blocks, and a fourth time block did not receive any music. Pairwise *t*-test comparisons indicated that testing time blocks which received music, demonstrated improved testing performance when compared to the testing blocks which did not receive music. Overall, silent testing Block 4 (M = 4.9, SE = 3.42) demonstrated the lowest mean quantity of questions answered correctly when compared to all other testing time blocks. Furthermore, conclusions from this study suggest that the quality of testing performance declines over time; as indicated by a decrease in the mean quantity of questions answered correctly across testing blocks: Block 2 (M = 8.2, SE = 3.44), Block 1 (M = 7.0, SE = 3.48), $t(23) = -2.551$, $p<.05$, Block 3 (M = 6.3, SE = 3.37), $t(23) = 2.888$, $p<.05$, and silent Block 4 (M = 4.9, SE = 3.42), $t(23) = 4.410$, $p<.05$.

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Ian Thomas Kells

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CHAPTER 1

INTRODUCTION

Statement of the Problem

Since the publication and subsequent mainstream attention of the Mozart Effect (Ky, Rauscher, & Shaw, 1993), there have been a number of studies dedicated to better understanding the effect of music on performance and intelligence. Ky, Rauscher, and Shaw (1993) initially conducted a study investigating the effect of listening to Mozart's sonata for two pianos (K448) for 10 minutes, on performance with spatial tasks. Initial results from this study indicated that there was an increase in performance (Ky, Rauscher, & Shaw, 1993). Many studies have attempted to replicate the initial Ky, Rauscher, and Shaw (1993) study, with some researchers using a number of different variables including different musical excerpts (Rideout and Taylor, 1997), age groups (Hui, 2006), EEG testing (Cacciafesta et al., 2015), and epilepsy (Jenkins, 2001, Lee et al., 2011) among others. Findings from these studies and other similar investigations have been mixed, and many researchers have expressed criticism for the Mozart Effect after analyzing and discussing their results (Bass, Crook, & Steele, 1999, Chabris, 1999, Formann, Pietschnig, & Voracek, 2010).

Although Ky, Rauscher, and Shaw (1993) have maintained support for their initial findings (Rauscher, 1998), attempts at replication have opened a new door into investigating the effects of music on performance, and the effects of arousal on performance (Hunter, Nakata, Schellenberg, & Tamoto, 2007). Despite the inconsistencies found within replications of the Ky, Rauscher, and Shaw (1993) study, it appears that the presence of arousing stimuli, and the potential effect of these stimuli on cognitive performance, may be significant. Roth and Smith (2008) suggest that the increases in spatial-temporal reasoning may be the result of a cognitive arousal effect. Other researchers have come to similar conclusions (Gadbois & Lints, 2003, Hallam & Schellenberg, 2005, Husain, Schellenberg, & Thompson, 2001, Nantais & Schellenberg, 1999). Roth and Smith (2008) recommend further study and interpretation of such data through an arousal theory hypothesis.

Rationale for Research

Current research reflects significant interest and investigation into auditory arousal and its effects on performance. However, current research literature appears to lack investigation into the effects of arousal on performance through an arousal hypothesis. Exposure to arousing stimuli appears to have an effect on performance during certain tasks, and Roth and Smith (2008) have suggested an interpretation of their data through an arousal hypothesis. This study endeavored to examine the relationships between levels of arousal, using subject-preferred auditory stimuli, and testing performance. The results of this study suggest that the relationship between levels of arousal and testing performance is positive, and in addition suggest that subjective states of arousal generally improved testing performance. Obtaining a better understanding of these results can assist in paving a path for the utilization, and improvement upon, of a methodology for further investigation into these relationships. Contributing to a better understanding of arousal and it's effects on performance could support the level of efficiency in treatment, and environmental supports, provided by music therapists and other health professionals.

Research Question

Research Question 1

Is there a relationship between music listening and Verbal Reasoning as measured by the Verbal Reasoning portion of the Graduate Record Exam?

Definition of Terms

Arousal is psychological state of alertness and readiness for action, or a pervasive state of cortical responsiveness believed to be associated with sensory stimulation, and therefore, activation of fibers from the reticular activating system (Psychological Dictionary, 2013). Arousal is also associated with a feeling, emotion, or response of awakening or the act of being excited by someone (Oxford Concise Medical Dictionary, 2010).

Summary

It can be suggested that literature relating to the topic of arousal and its effect on increases in performance, has evolved in a direction from first replicating the initial Ky, Rauscher, and Shaw (1993) Mozart Effect study, to testing for stimuli which may or may not increase an individual's performance on certain tasks, to testing for the specific nature of arousing stimuli and their effect on mood and performance. Obtaining a better understanding of arousal states and their relationship to levels of performance could provide music therapists and other health professionals with a more comprehensive approach to treating their patients and providing more efficient environmental supports. Utilizing a certain methodology for investigating these relationships between arousal and performance could also help to provide a framework for future investigation into this topic.

CHAPTER II

REVIEW OF LITERATURE

Arousal

Psychological and physiological arousal states have been studied for over a century. Some of the earliest investigations concerning arousal revolve around the *Yerkes-Dodson Law*, first developed in 1908. (Zajonc's arousal and confluence theories, 2006). The *Yerkes-Dodson Law* suggests that high levels of arousal will typically improve performance on simple or well-learned tasks (Campbell et al., 2007; Zajonc's arousal and confluence theories, 2006), as well as enhance performance on moderate or more difficult tasks (Broadhurst, 1957; Gross, Sheppes, & Suri, 2015). Conversely, a decrease in arousal can lead to a corresponding digression in performance (Forster & Davis, 1994; Han et al., 2013; Zajonc's arousal and confluence theories, 2006). A heightened level of arousal also manifests itself physiologically to include increases in heart rate and brain activation (Daneshvar, Dousty, & Haghjoo, 2011).

These processes are proposed to be possible, in large part, through the brain's reticular activating system. This system is made up of nerve pathways and incorporates information from all of the senses, as well as from the cerebrum and cerebellum. With an accumulation of this information, the reticular activating system determines the overall activity of the brain, autonomic nervous system, and patterns of behavior. Levels of both high alertness and attention, as well as low levels of arousal such as relaxation and drowsiness are monitored and modulated through the reticular activating system (Berridge, C.W., Espana, R.A., & Schmeichel, B.E., 2016; Oxford Concise Medical Dictionary, 2010; Shigeo et al., 1996).

An activation/arousal theory, introduced by American physiological psychologist Donald B. Lindsley, suggests that the concepts of cognitive activation and cognitive arousal are related, but not synonymous. This means that although states of arousal are linked to behavioral and motivational states, an arousal state is not itself the behavior or action often seen as a product of arousal (Roeckelein, 2006). The reticular activating system was long thought to be the primary mechanism in translating arousal states into conditions of consciousness or behavior. As a result of continuing investigation into the reticular activating system, it was found that this system might not be the sole cognitive force for this process (Shigeo et al., 1996). Although the relationship between arousal and behavior have been strongly correlated and well investigated in research literature, the cognitive mechanisms involved are not fully understood (Roeckelein, 2006).

The Elsevier's Dictionary of Psychological Theories associates different states of arousal with behavior and motivation, or drive (Theories of motivation, 2006). In this case, the behaviors of an individual, which aspire towards or away from particular areas of focus or goals, are a result of the individual's state of arousal (Theories of motivation, 2006). Yerkes and Dodson have suggested that cognitive and motivational processes have a pronounced dependency on arousal (Yerkes & Dodson, 1908).

The concept of action readiness is based upon the level of ease involved in the initiation of action, when taking into account an individual's state of arousal prior to the action (Gross, Sheppes, & Suri, 2015). Currently, it is proposed that the brain balances the values of a stimulus and an action. In other words, a high level stimulus would provide a higher level of energy and therefore sustain a higher level of motivated action (Gross, Sheppes, & Suri, 2015). Gross, Sheppes and Suri (2015) discuss this idea and elaborate further to suggest that the effect of a low level stimulus tends to result in low levels of motivated action. Conversely, if a higher-level stimulus is involved it tends to increase the likelihood of higher levels of motivated action.

These ideas are then demonstrated by an increase in speed and accuracy for certain testing materials, especially with previously encountered and subjectively favorable stimuli (Forster & Davis, 1994; Hallam, Price, & Katsarou, 2002; Särkämö et al., 2008; Thompson, Schellenberg, & Husain, 2001; Wallace, 1994).

There is also a relationship between arousal states, emotion, mood, and cognition. The basis for much of the contemporary research concerning these relationships seems to be found in Schacter's cognitive-arousal theory of emotion (Schachter & Singer, 1962). Here, Schacter explains emotion as the combination of an arousing stimulus and an individual's cognitive perceptions of the stimulus. In an analysis of modern literature concerning elaborations and interpretations of the cognitive-arousal theory of emotion, Schacter & Singer (1962) explain that arousal states determine the subjective intensity of an experienced emotion. In addition to this, the individual's cognitive perceptions of this arousal state then determine its specific categorization (ex. happy, sad) (Schachter & Singer, 1962; Cavanagh & Davey, 2001).

Thayer (2000) elaborates further on this arousal and emotion/mood based hypothesis. According to Thayer's paper, arousal has a direct effect upon mood, though arousal does not carry a definitive positive or negative implication. Moods are generated by "energetic and tense arousal" (p.203). This arousal state, as it increases, can be energizing and motivating. However, after a point the level of arousal decreases and the levels of an individual's energy will also decrease (Thayer, 2000). Along with this decrease in energy is a decrease in the subjective intensity of an emotion or mood.

Nealis, Van Allen, & Zelenski (2016) contribute to this conversation on the quality of arousal states. For example, excitement is considered a positive, high arousal state. Conversely, relaxation would be considered a positive, low arousal state. Nealis, Van Allen, & Zelenski

(2016) conducted a collective of four studies utilizing arousal states to improve mood, in order to investigate this process on improvements in performance on a hand grasp task. Though a bulk of the results of the studies was inconclusive, they did find an improved performance when experiencing positive, high arousal states (Nealis, Van Allen, & Zelenski, 2016).

These mood and arousal states were investigated further by Cavanagh & Davey (2001). Cavanagh & Davey (2001) explain that when an individual is in a negative mood, and experiences a high arousal state, that this can greatly affect their stress levels. It is suggested that during these times of high stress it is possible that an individual may develop phobias and supplementary fear based problems. This research into the role of arousal and mood on expectancy biases, specifically towards unconditioned stimuli resulted in a probable relationship between mood and arousal. Specifically, that a negative mood might cause a non-specific rise in an individual's level of arousal (Cavanagh & Davey, 2001).

Arousal and Performance

The increasing amount of research regarding the effects of arousal states on both physiological and cognitive processes is further examined through investigations concerning the effects of different kinds of arousing stimuli on performance. In 2013 Han et al. conducted a study investigating the relationship between arousing noises and quality of performance. A variety of pseudo sentences were used to provide varying acoustic qualities. Han et al. (2013) discusses that typically it has been found that background noises have a tendency to decrease the quality of cognitive processing, in turn negatively affecting the performance of an individual. The results of the study suggest that low levels of arousal improved speed and accuracy in performance, especially in comparison to a silent and high arousal condition. It was found that the arousal instigated by the background noise had a significant effect on performance, regardless of the acoustic qualities of the background noises. Lower levels of speed and accuracy in performance during high arousal conditions may represent a state of hyper-arousal (Han et al., 2013).

In an investigation into the effects of white noise on performance, Bamford et al. (2014) suggest that the attention abilities of individuals may also play a role in the way an arousing stimulus affects their performance. The results of a study by Bamford et al. (2014) suggest that different levels of white noise arousal will have different effects upon different individuals due to their attention abilities (Bamford et al., 2014). Baijot et al. (2016) who studied the effects of white noise on children diagnosed with ADHD confirms this in their findings. The findings of that study suggest that white noise has a positive effect on performance with certain cognitive tasks. This effect of the white noise arousing stimulus remained that same across subjects, with or without the subject's diagnosis associated medications (Baijot et al., 2016).

Research has also been conducted concerning the effects of physiological arousal on cognitive task performance. Lambourne & Tomporowski (2010) studied the effects of both acute and long-term cardiovascular exercise on certain cognitive tasks in a meta-regression study. The results of this study indicated that acute exercise diminished the cognitive abilities of subjects. However, this effect only lasted for the first twenty minutes of activity. Physiological activity lasting more than twenty minutes appears to enhance an individual's speed and accuracy in completing certain cognitive tasks (Lambourne & Tomporowski, 2010).

Building on this line of research, arousal has been shown to enhance performance on certain tasks, as a mediating variable following exposure to musical stimuli (Altorfer et al., 2009; Perham & Withey, 2012). Evidence has been presented supporting the use of music to improve performance in a multitude of arenas from driving a car (Epstude et al., 2013) to increasing the speed and accuracy of cognitive tasks (Ivanitskii, Portnova & Sysoeva, 2011; Gross, Sheppes, & Suri, 2015), to the rehabilitation of traumatic injury (Ivanitskii, Portnova & Sysoeva, 2011).

Julkunen et al. (2014) write that arousal can enhance readiness for response to sensory information. Using transcranial magnetic stimulation (TMS) with acoustic stimulation, Julkunen et al. (2014) conducted a study using eight individuals to determine the effect of auditory stimuli. The results of the study indicated that auditory stimulation could activate sensory cortices as well as the central motor system (Julkunen et al., 2014).

Ivanitskii, Portnova & Sysoeva (2011) conducted a study utilizing background auditory stimulation. These researchers utilized a basic rhythm played in the background with varying degrees in speed. Not all conditions demonstrated improvements, however the results suggest that slower rhythmic stimulation led to the subjects completing tasks more quickly and accurately. The opposite was found when the tasks included subjective judgments of time duration. Although the subjects seem to have suffered in terms of subjective time keeping, it appears that an improvement in task performance and speed can be found as a result of musical rhythms being used as arousing stimuli (Ivanitskii, Portnova & Sysoeva, 2011).

In a study by Autti et al. (2008), the relationship between auditory arousal and cognitive performance regarding cognitive recovery after a middle cerebral artery stroke is studied and discussed. Autti et al. (2008) discuss the general benefits of stimulus rich environments for recovering stroke patients, and suggest that their investigation into sound and auditory stimuli found positive results as well. The findings from Autti et al. (2008) suggest that listening to music during cognitive recovery from middle cerebral artery stroke can increase the speed of recovery as well as support the development of positive moods (Autti et al., 2008).

In the book *Rhythm, Music, and the Brain* (2005) Thaut presents a relationship between art, arousal, and activation as described by Berlyne in his 1971 book *Aesthetics and Psychobiology* (Thaut, 2005). Here, the individual experiences a stimulus that influences a physiological arousal, and ultimately leads to the activation of behavior and response (Thaut, 2005, p. 19). This interpretation of arousal offers a demonstration of the relationship between arousal and effect. Thaut (2005) reviews a great deal of research to better explain and understand the use of arousal and activation, among other principles, for the therapeutic use of music in the field of neurorehabilitation. Rhythmic auditory stimulation appears to enhance motor function in patients with Parkinson's Disease (PD). This implies that those with PD can execute planned motor functioning when stimulated via external cues using musical stimulation. This ends up circumventing the defective internal trigger originating in the basal ganglia (Corcos et al., p. 626, 2011)

Perham & Withey (2012) investigated the effects of music on spatial rotation performance. Ideally, Perham & Withey (2012) began this study with the intention of investigating any relationships between arousal, mood, preferred music, cognitive performance, and specific rhythmic tempos. The results of this study concluded that, regardless of the music's rhythmic tempo, listening to preferred music before testing improved performance on spatial rotation tasks (Perham & Withey, 2012).

Hallam & Schellenberg (2005) conducted a study concerning spatial task tests with children ages ten to eleven years. Results from more than 8,000 ten and eleven year olds were then reanalyzed to better understand their potential relationship to the arousal and mood hypothesis, as well as provide additional validation for their initial findings. Initial analysis of the data demonstrated no relationship with the Mozart Effect. However, reanalysis brought to light an idea the authors call a “Blur effect.” The “Blur effect” suggests that children who listen to popular music by Blur and two other similar artists performed better on spatial reasoning tasks then children who did not listen to these artists. In discussing the “Blur Effect” the researchers in this study are continuing to contribute to a body of research intimating that the rationale for an increase in performance when listening to music is based upon the cognitive arousal that results from hearing preferred or arousing music, prior to completing cognitive tasks (Hallam & Schellenberg, 2005). This agrees with the results of Hallam et al. (2002) in which a study of children ages 10-12 yielded similar results. In this study however, it was found that low levels of arousal had the most positive effects on performance. Soothing and calming music were found to increase performance in arithmetic and memory tasks, as opposed to more arousing and disruptive music. Hallam et al. (2002) suggest that the results of this study indicate that arousal and mood play a primary role in affecting performance as opposed to specific pieces or types of music (Hallam et al., 2002).

The Mozart Effect

Following the publishing of Ky, Rauscher, and Shaw’s (1993) study on the Mozart effect, there was a wave of public acceptance and interpretation of these results. A large number of products, programs, and even public policy were affected by the idea that listening to Mozart could make one more intelligent. One such public case is the budgeting of the Georgia Governor Zell Miller to provide a CD or cassette tape recording of Mozart to each infant born in the state. The company Sony assisted the governor by producing the music at no charge to taxpayers (Etheridge, 1998). Public considerations of the results for Ky, Rauscher, and Shaw’s (1993) study were taken seriously and the idea that music listening and music lessons might improve cognitive abilities was discussed by a number of journalistic entities including reports in the public press such as the APA monitor, CNN, Science Magazine. Mozart products were produced nationwide including audio CD's and programs such as "Mozart Makes You Smarter", a Mozart Effect online resource center found at mozarteffect.com, "Music for the Mozart Effect" CDs published by Don Campbell, recommendations from the media, and books on how to use the Mozart Effect to tap into the healing and mind strengthening powers of the composer such as those written by Don Campbell and Keith Wagner.

These products, though promoted with less assertion than in the decade surrounding the publication of Ky, Rauscher, and Shaw's (1993) study, are still both available and produced in the present. Over time, replications and expansion upon Ky, Rauscher, and Shaw's (1993) results suggested that the music of Mozart may not have any specific effect on performance or intelligence, but that an arousal effect may make for a more plausible explanation.

Brown and Wilson (2015) conducted a study in which they reexamined the effect of auditory stimuli on cognitive performance and IQ levels, taking exception to the assertion that classical music, Mozart in particular, is responsible for this increase in cognitive performance on spatial-reasoning tasks. Brown and Wilson (2015) attempted to replicate the initial Ky, Rauscher, and Shaw (1993) study using mazes which were to be solved by drawing lines with a pencil after exposure to Mozart, relaxation music, and a silent condition (Brown & Wilson, 2015). A result of this study concluded that those who were presented with the Mozart condition last performed with fewer errors on the maze task than when the Mozart condition was presented prior to relaxation music and silence conditions. In addition, Brown and Wilson (2015) concluded that although both relaxation music and Mozart increased performance accuracy among subjects, that Mozart yielded the highest performance levels on the maze tasks.

In 1999, Nantais and Schellenberg conducted a study to examine the effects of exposure to music on presented a spatial-temporal task. In this study, Nantais and Schellenberg (1999) suggest that the initial findings of Ky, Rauscher and Shaw (1993) may have presented an issue of arousal, in that the control conditions used (silence and a relaxation tape) could have been found to be much less arousing than listening to Mozart (pg. 370). Nantais and Schellenberg (1999) found that those who listened to Mozart or Schubert performed better on spatial-temporal tasks than those in the silence condition. It seems likely then, that the effect would generalize to a wide variety of enjoyable pieces of music as opposed to Mozart exclusively (pg. 372). This result from Nantais and Schellenberg (1999), as well as additional discussion concerning the lack of evidence for discerning between the music of Mozart and other preferred or engaging auditory stimuli, begs for continued discussion and research concerning the effect of auditory stimuli on performance (Nantais & Schellenberg, 1999).

Gadbois and Lints (2003) studied participants in 2 expectancy conditions and 4 different task conditions in order to test the effects of the participants' expectations on performance. The four testing conditions utilized during this study included: verbal reasoning, spatial reasoning, Mozart sonata, and Mozart symphony (Gadbois & Lints, 2003, pg. 1169). The authors of this study hoped to generalize the effects of Ky, Rauscher, and Shaw (1993) to an additional symphony by Mozart (Gadbois & Lints, 2003, 1171). Although expectancy was not found to have a significant effect on performance, Gadbois and Lints (2003) consider their study to be a part of the current body of research that "refutes the existence of the Mozart Effect" (pg.1172). In addition, the authors continue on to discuss the presence of an arousal or priming effect during the study (Gadbois & Lints, 2003).

Rideout and Taylor published a study in 1997 replicating the effects of exposure to 10 minutes of music, and a control condition of silence, prior to initiating testing on 2 sets of spatial task questions. The findings were similar to that of Ky, Rauscher, and Shaw (1993), however these authors did not utilize Mozart specifically. The results for Rideout and Taylor (1997) indicated a significant improvement in test performance from those participants who had been exposed to music prior to testing.

Arousal Theory

Although a great deal of research has been dedicated to the effects of music and auditory stimulation on performance, it seems that arousal states may have more direct impact on performance than any particular form of arousal inducing stimulus. In a 1999 investigation of the Mozart Effect, Nantais et al. used music by both Mozart and Schubert in comparison to a silent condition. The results of this study suggested that the implications of the "Mozart Effect" did not actually require the music of Mozart. Nantais et al. elaborated further on this point to identify the possibility that an effect similar to the Mozart Effect could be observed in any environment in which a positive arousing stimulus is paired with a less positive or engaging stimulus. Husain, Shellenberg, and Thompson (2002) discuss an arousal-mood hypothesis. This hypothesis describes music as an arousing stimulus that causes increases in performance, based upon the arousal state that is produced (Husain, Schellenberg, & Thompson 2002). This hypothesis moves in the direction of an arousal hypothesis, focused more upon the arousal state and it's affects upon performance as opposed to the stimulus used.

In 2008 Roth and Smith investigated the effect of music listening for performance on a 25-question portion of the analytical section of the Graduate Record Exam by 72 undergraduate students. The results of the study demonstrated that there was no pairwise difference. The findings were interpreted in terms of an arousal framework, suggesting the higher means in all auditory conditions may reflect immediate exposure to auditory stimuli. Exposure to arousing stimuli appears to have a marked effect on performance during certain tasks, and Roth & Smith (2008) have suggested an interpretation of their data through an arousal hypothesis. In reviewing current research literature it appears that this arousal hypothesis has not yet been tested, nor has its direct relationship to any quantitative decay effect in performance on certain tasks.

To further illustrate this evolving interest, in 2001 Husain, Schellenberg, and Thompson conducted a study in which participants completed a test of spatial abilities after listening to music, or sitting in silence. This study also measured additional factors including self-reported levels of enjoyment, arousal, and mood. The musical stimuli exposed to participants in this study include the original Mozart excerpt and in addition a slow and sad Albinoni excerpt. The results of this study suggested that the Mozart Effect is an artifact of arousal and mood. The authors of this study discussed this idea further to suggest that if the Mozart Effect is a consequence of arousal and mood, then similar increases in performance on spatial tasks should be observed following exposure to pleasant and engaging stimuli other than music (Hussain, Schellenberg, & Thompson, 2001).

In 1999, Thaut and Hinshaw conducted a study including auditory and visual stimuli and found evidence for an increase in performance across all participants who had been exposed to arousing stimuli prior to testing when compared to participants who had been exposed to a control silence condition prior to testing. This study, in accordance with other studies evolving from the same topic, appears to suggest an interest not just in the effects of the initial Ky, Rauscher, and Shaw (1993) findings, but in the investigation of arousal stimuli and their effect on performance. Thaut and Hinshaw (1999) suggested that the improvement of performance by participants might be linked to a priming effect due to an exposure to structural changes taking place in each of the presented stimuli.

Subject-identified Music

In 2014 Nelson and Sim investigated whether positive affect had an effect on social problem solving utilizing dispositional optimism with positive and negative statements. Initial findings from this Nelson and Sim (2014) study suggest that positive emotions such as "joy, contentment, or amusement" can influence an individual's performance on social problem solving tasks; defined as "identifying effective or adaptive strategies for problem solving" (pg. 635-636). Ingenuity and insight were also found to have demonstrated an increase in groups experiencing positive affect during the study (Nelson & Sim, 2014).

Daubmen, Isen, and Nowicki (1987) studied the effects of positive affect on creative problem solving. According to the results of this study positive affect can have a positively influential effect on an individual's performance on problem solving tasks (Daubmen, Isen, & Nowicki, 1987, pg. 1123). In addition to these findings, the authors of this study continue on to discuss an alternative interpretation of the effects observed. Daubmen, Isen, and Nowicki (1987) discuss that positive affect comprises an aroused state. Although there was not sufficient evidence to constitute that arousal alone was responsible for the increase in performance, the authors of this study found it important to note the potential link between arousal and positive affect (pg. 1129).

Concerning the use of subject-identified auditory stimuli, it's important to consider the diversity of personality types and subject sensory experiences across subjects. The importance of this consideration is based around the desire to avoid hyper and hypo arousal states in subjects. Russell Geen (1984) conducted a study regarding arousal states and both extroverted and introverted subjects. When both extroverted and introverted subjects experienced the same level of auditory stimulation, the introverts experienced a higher level of arousal than extroverts. However, when introverted and extroverted subjects were given the opportunity to choose their own levels of auditory stimulation, it was found that both introverts and extroverts experienced the same level of arousal (Geen, 1984).

In studying the brain patterns and activity of musicians and non-musicians Gaser and Schlaug (2003) found that there are notable differences in gray matter activity between musicians who practice for more than 1 hour a day, musicians that practice for less than 1 hour a day, and non-musicians. In addition musicians who practice more than 1 hour a day demonstrated higher activity in areas of the brain used for visuo-spatial processing as well as a higher likelihood of choosing actions based upon visual stimuli (Gaser & Schlaug pg. 9243). This study by Gaser and Schlaug (2003) suggests that differences in learning, processing, and responses are different between musicians and non-musicians.

Summary

Scientific inquiry concerning the Mozart Effect has garnered a great deal of attention. Though many different researchers have attempted to both modify and replicate the initial study conducted by Rauscher, Shaw, and Ky in 1993, results concerning a Mozart-specific effect have been varied. However, many studies branching from this original idea of the Mozart Effect begin to reveal a potential consistency, that is, a cognitive arousal effect that may be responsible for increases in performance on certain tasks. Rideout and Taylor (1997) studied the effect of music on cognitive performance. The results for this Rideout and Taylor (1997) study indicated a significant improvement in test performance from those participants who had been exposed to music prior to testing, and not Mozart specifically. Roth and Smith, in their 2008 study, suggest that an increase in spatial-temporal reasoning may be the result of a cognitive arousal effect. It is therefore evident that the effects of arousal on performance need to be interpreted through an arousal theory framework.

CHAPTER III

METHOD

Participants (8 Males, 16 females)

A total of twenty-nine subjects were recruited for this study from a sample of non-music students at Western Michigan University (WMU). Twenty-four of these students' data were analyzed for this thesis (see table 1). Subjects were recruited through the use of advertisements posted in the WMU College of Health and Human Services with the assistance of the *Brain Research and Interdisciplinary Neurosciences* (B.R.A.I.N.) lab manager Amanda Ziemba (Appendix A). B.R.A.I.N. lab manager Amanda Ziemba also assisted in the subject recruitment process by sending advertisements for this study to Occupational Therapy, Psychology, and Biology professors in the WMU College of Health and Human Services via email. A recruitment script was utilized for potential subjects expressing interest to the researcher via email and phone (Appendix B; Appendix C; Appendix D). In order for this study to be sufficiently powered, a G-Power (version 3.1) analysis was run to determine the need for twenty-four subjects based upon a within subjects research design.

Table 1

Demographics of Participants

Sex	Frequency
Male	8
Female	16
Total	24

Due to the listening and test taking requirements of participation in this study, certain limitations were applied in the subject recruitment process. Individuals with hearing, visual, or cognitive impairments were not included in this study. Subjects were also required to be between the ages of 18 and 65. This age range would include any non-traditional WMU students, as well as minimize the risk of hearing and visual loss from participants over the age of 65. Individuals with more than one year of formal music training were also not included in the study (Gaser & Schlaug, 2003; Roth & Smith, 2008).

Research Design

A within subjects research design was applied for this study. The within subjects design was chosen for the purposes of comparing four testing time blocks across all subjects data.

Apparatus

The data collection process was administered in the WMU Brain Research and Interdisciplinary Neurosciences (BRAIN) lab using a 2012 iMac with a 27" monitor display. Prior to the initiation of the study, all potential subjects provided the researcher with a self-selected song that the potential subject found to personally induce a feeling of motivation. This information was gathered using a music preference form (Appendix E). All subject-preferred music was then purchased and downloaded from iTunes to ensure that all music was of the same audio quality. Each of the subject-preferred music choices utilized in this study may be found in Appendix F. The subject-identified music was administered during testing using Koss UR-20 Home headphones.

Testing materials were taken from the Verbal Reasoning practice exams of the 2012 *Official Guide to the GRE revised General Tests*. This portion of the GRE provides excerpts that must be read in order to answer the exam's corresponding questions. The Verbal

Reasoning portion of the GRE was selected due to the estimated time required to answer each question; in order to assess attention decay, each question should take no less than one minute and no longer than three minutes to answer on average.

Procedure

Upon receiving interest from potential subjects the investigator provided the necessary documents requiring review and signature before participating in the study. These documents included the WMU Human Subjects Institutional Review Board informed consent form (WMU HSIRB) (Appendix G), an availability form (Appendix H), and the subject's preferred music choice form (Appendix E). After completing and returning the initial forms to the investigator, the subject then proceeded to schedule a time with the researcher to begin the data collection process.

Before the data collection process could begin, the subject was asked to review the WMU HSIRB informed consent form (Appendix C). During the data collection process the subject was instructed to sit at a computer on which the testing was to be administered. The subject was instructed to place a pair of headphones on their head. A set of recorded instructions was relayed to the subject via the headphones, and the subject was directed to adjust the volume of the audio, if needed, during this time. After the recorded instructions had finished being relayed, an EDA monitor was applied. The EDA monitor was placed on the subject's non-dominant hand and electrodes were placed on the distal pad of the third and fourth digits of the non-dominant hand. The EDA monitor was used in order to measure arousal responses via electro dermal skin responses. The B.R.A.I.N. lab manager Amanda Ziemba and B.R.A.I.N. lab assistant Sheridan Brown administered placement of the

EDA monitor for each subject. The subject was asked to maintain the position of their hand, and avoid movement during testing. Verbal instructions were then provided to the subject on how to use the computer in order to take the test, and the subject was informed that their preferred song choice would be administered via the headphones during testing. The subject was not informed as to the frequency of the administration of their preferred music choice nor the testing time blocks in which their data would be organized. The headphones and EDA monitor remained in place throughout the duration of the data collection process.

Subjects then began testing for a total of sixty-minutes which were then analyzed across four testing time blocks. Each time block lasted for fifteen-minutes for a total continuous data acquisition period of sixty-minutes. Each subject experienced the introduction of his or her own preferred music selection in three-minute increments. This music selection was administered at three different times during testing with no administration of music during time Block 4 (see figure 1):

1.) 3 minutes of music prior to the commencement of time Block 1
2.) 3 minutes of music, during testing, at the commencement of time Block 2
3.) 3 minutes of music, during testing, at the commencement of time Block 3
4.) No music administered at the commencement of time Block 4

Testing was administered using the GRE Verbal Reasoning practice exam, with the same practice exam test being provided for each subject. These GRE Verbal Reasoning questions were administered with the use of a custom MATLAB program with the assistance of Dr. Stephen Tasko. The order in which the questions were presented was randomized so that no subject was likely to receive the same questions in the same order as another subject. No more than one subject received testing at a time. After completing their participation in the study, compensation was provided in the form of a gift card; however, compensation was not offered in the case that the subject chose to withdraw from the study before completion. All testing took place at the B.R.A.I.N. lab on Western Michigan University's campus in the College of Health and Human Services Building.

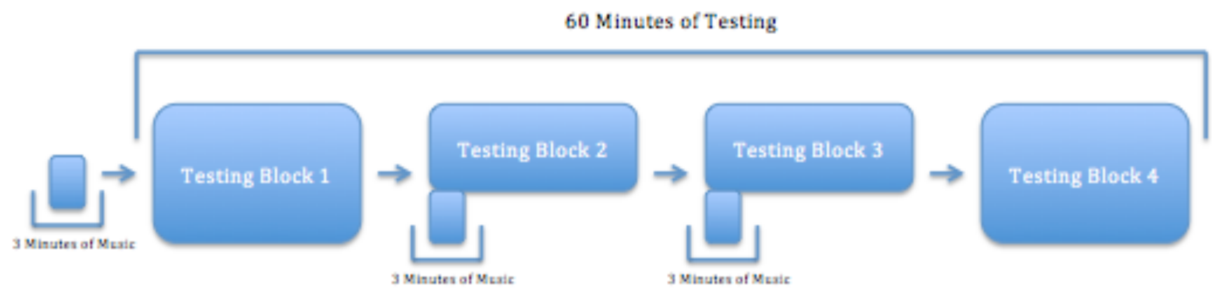


Figure 1. Data Collection Procedure Flowchart

Analysis of the Data

The sixty-minute testing period was separated into four testing time blocks for each subject, and each of these blocks were analyzed using pairwise *t*-test comparisons. The outcomes from the pairwise *t*-test comparisons were then analyzed across four categories: The quantity of questions answered, the quantity of questions answered correctly, the percentage of questions answered correctly, and the average duration of individual questions answered. EDA related data was not analyzed as a part of this thesis.

CHAPTER IV

RESULTS

Pairwise *t*-tests were conducted in order to compare mean differences between each of the testing time blocks across subjects. These pairwise *t*-tests were then conducted in four different categories including the quantity of questions answered, the quantity of questions answered correctly, the percentage of questions answered correctly, and the average duration of individual questions answered. All data has been reported using *Discovering Statistics Using SPSS* third edition, as an analytic guide. The alpha level was set at .05 based upon the British Psychological Society and American Psychological Association standards.

Quantity of Questions Answered

Results for the analysis of the quantity of questions answered indicated significant mean differences between Block 2 (M = 17.2, SE = 4.83 and all other testing time blocks. On average, subjects answered a higher quantity of questions in Block 2 (M = 17.2, SE = 4.83) than in Block 1 (M = 14.3, SE = 4.86), $t(23) = -5.695$, $p<.01$, Block 3 (M = 14.1, SE = 3.30), $t(23) = .113$, $p<.05$, and Block 4 (M = 12.3, SE = 4.10), $t(23) = 3.731$, $p<.05$ (see table 2).

Subjects demonstrated a slight decrease in the mean quantity of questions answered in Block 1 (M = 14.3, SE = 4.86) when compared to Block 2 (M = 17.2, SE = 4.83). On average, subjects answered a higher quantity of questions in Block 1 (M = 14.3, SE = 4.86) than in Block 3 (M = 14.1, SE = 3.30), $t(23) = .113$, $p>.05$, and Block 4 (M = 12.3, SE = 4.10), $t(23) = 1.441$, $p>.05$.

Table 2

Quantity of Questions Answered Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Block 1	24	7.00	29.00	14.3	4.86
Block 2	24	10.00	31.00	17.2	4.83
Block 3	24	8.00	23.00	14.1	3.30
Block 4	24	.00	19.00	12.3	4.10

Note: Quantity of Questions Answered Descriptive Statistics.

Subjects demonstrated a slight decrease in the mean quantity of questions answered in Block 1 (M = 14.3, SE = 4.86) when compared to Block 2 (M = 17.2, SE = 4.83). On average, subjects answered a higher quantity of questions in Block 1 (M = 14.3, SE = 4.86) than in Block 3 (M = 14.1, SE = 3.30), $t(23) = .113$, $p>.05$, and Block 4 (M = 12.3, SE = 4.10), $t(23) = 1.441$, $p>.05$.

Pairwise *t*-tests also indicated significant mean differences between Block 3 (M = 14.1, SE = 3.30) and Block 2 (M = 17.2, SE = 4.83), as well as Block 3 (M = 14.1, SE = 3.30) and Block 4 (M = 12.3, SE = 4.10) (see table 3). On average, subjects answered a higher quantity of questions in Block 3 (M = 14.1, SE = 3.30) than in Block 4 (M = 12.3, SE = 4.10), $t(23) = 2.174$, $p<.05$.

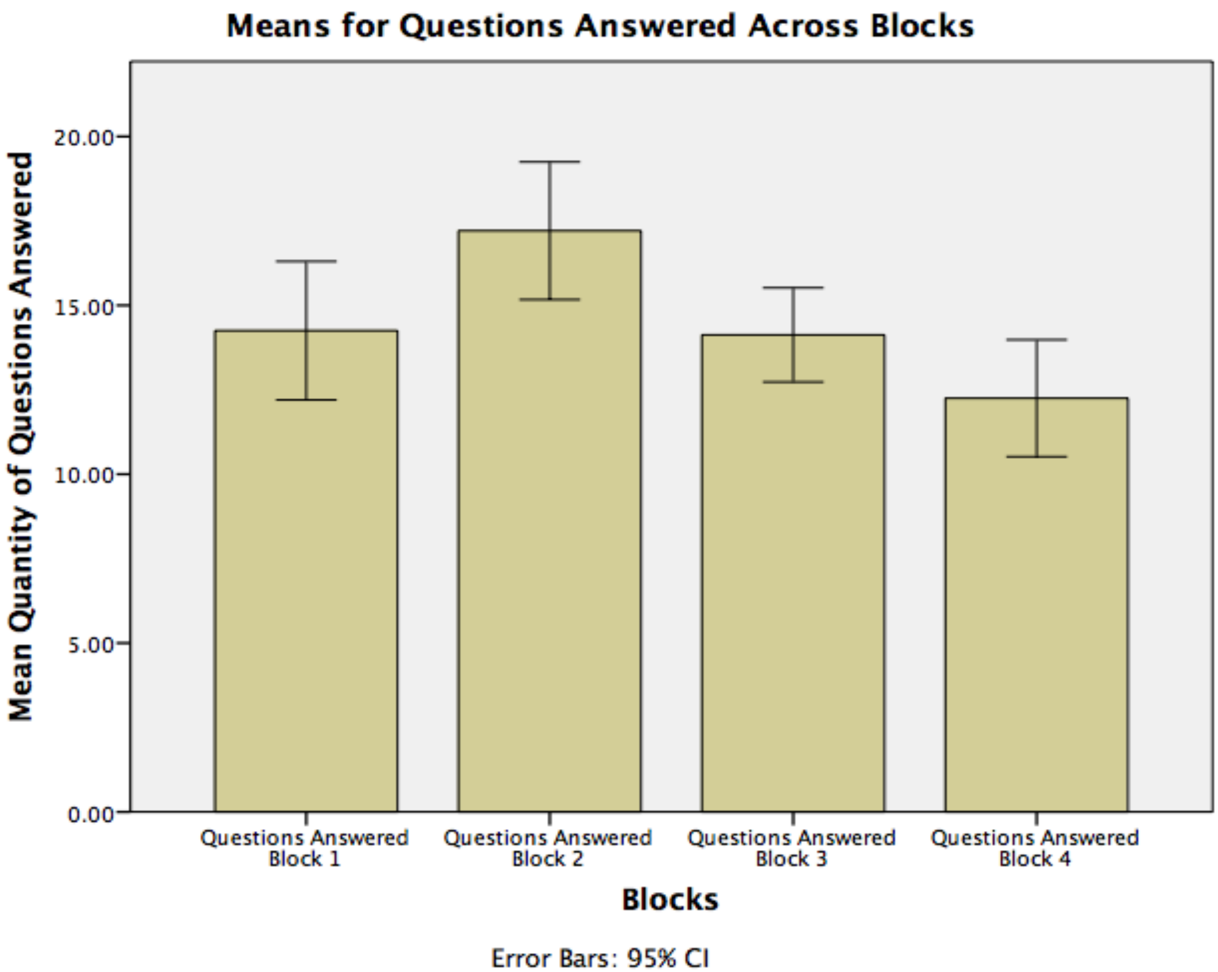
Table 3

Quantity of Questions Answered Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Block 1-Block 2	-5.70	23	.00
Pair 2	Block 1-Block 3	.11	23	.91
Pair 3	Block 1-Block 4	1.44	23	.16
Pair 4	Block 2-Block 3	2.86	23	.01
Pair 5	Block 2-Block 4	3.73	23	.00
Pair 6	Block 3-Block 4	2.17	23	.04

Note: Quantity of Questions Answered Paired Samples Test.

Block 4 (M = 12.3, SE = 4.10) demonstrated significant mean differences with Block 2 (M = 17.21, SE = 4.83) and Block 3 (M = 14.1, SE = 3.30). Overall, Block 4 (M = 12.3, SE = 4.10) also demonstrated the lowest mean quantity of questions answered when compared to all other testing time blocks.



The above graph demonstrates the mean quantities of questions answered for all subjects in each of the four testing time blocks.

Figure 2. Mean Quantities of Questions Answered.

Quantity of Questions Answered Correctly

Results for the analysis of the quantity of questions answered correctly also indicates that significant mean differences were found between Block 2 (M = 17.2, SE = 4.83) and all other time blocks. On average, subjects answered a higher quantity of questions correctly in Block 2 (M = 8.2, SE = 3.44) than in Block 1 (M = 7.0, SE = 3.48), $t(23) = -2.551$, $p<.05$, Block 3 (M = 6.3, SE = 3.37), $t(23) = 2.888$, $p<.05$, and Block 4 (M = 4.9, SE = 3.42), $t(23) = 4.410$, $p<.05$ (see table 4).

Block 1 (M = 7.0, SE = 3.48) demonstrated significant mean differences when compared to Block 3 (M = 6.3, SE = 3.37) and Block 4 (M = 4.9, SE = 3.42). On average, subjects answered a higher quantity of questions correctly in-

Table 4

Quantity of Questions Answered Correctly Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Block 1	24	1.00	15.00	7.0	3.48
Block 2	24	4.00	21.00	8.2	3.44
Block 3	24	1.00	12.00	6.3	3.37
Block 4	24	.00	14.00	4.9	3.42

Note: Quantity of Questions Answered Correctly Descriptive Statistics.

-Block 1 (M = 7.0, SE = 3.48) than in Block 3 (M = 6.3, SE = 3.37), $t(23) = .819$, $p>.05$ and Block 4 (M = 4.9, SE = 3.42), $t(23) = 2.671$, $p<.05$.

Results from analysis of Block 3 (M = 6.3, SE = 3.37) indicate a significant mean difference with Block 4 (M = 4.9, SE = 3.42) (see table 5). On average, subjects answered a higher quantity of questions correctly in Block 3 (M = 6.3, SE = 3.37) than in Block 4 (M = 4.9, SE = 3.42), $t(23) = 2.435$, $p<.05$. Overall, Block 4 (M = 4.9, SE = 3.42) demonstrated the lowest mean quantity of questions answered correctly when compared to all other testing time blocks (see figure 2).

Table 5

Quantity of Questions Answered Correctly Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Block 1 - Block 2	-2.55	23	.02
Pair 2	Block 1 - Block 3	.82	23	.42
Pair 3	Block 1 - Block 4	2.67	23	.01
Pair 4	Block 2 - Block 3	2.89	23	.01
Pair 5	Block 2 - Block 4	4.41	23	.00
Pair 6	Block 3 - Block 4	2.44	23	.02

Note: Quantity of Questions Answered Correctly Paired Samples Test.

The above graph demonstrates the mean quantities of questions answered correctly for all subjects in each of the four testing time blocks.

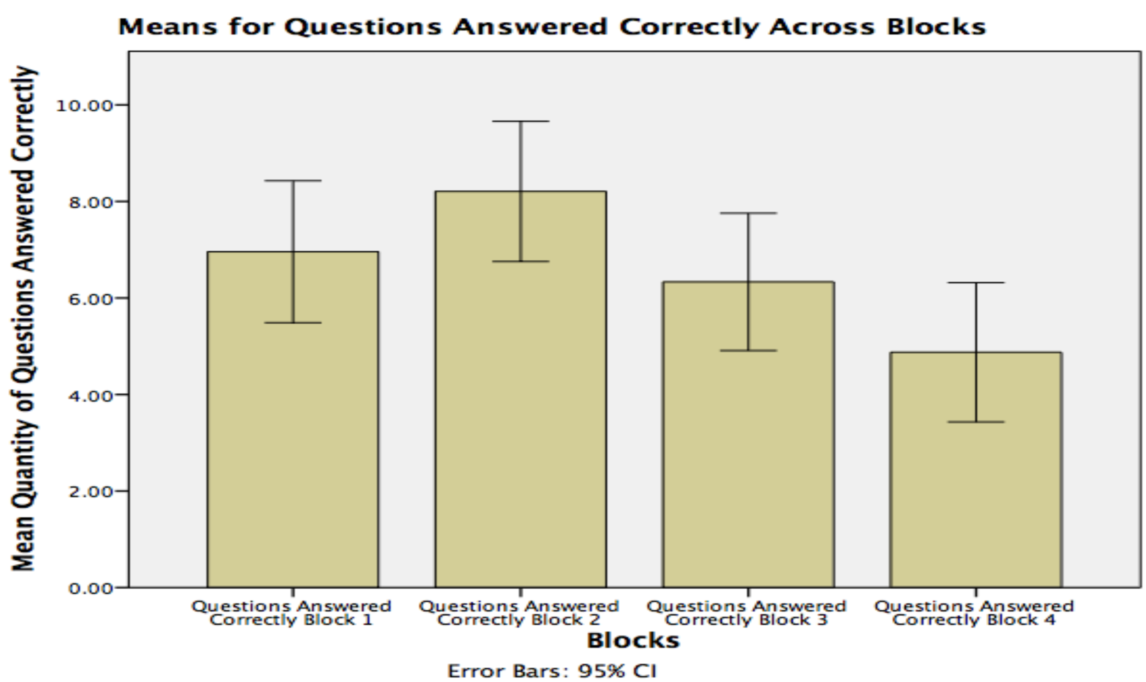


Figure 3. Mean Quantities of Questions Answered Correctly.

Percentage of Questions Answered Correctly

Results for the analysis of the percentage of questions answered correctly indicate that Block 2 (M = .5, SE = .17) contained the highest mean for the percentage of questions answered correctly (see table 6). Block 2 (M = .5, SE = .17) demonstrated one significant mean difference, with Block 4 (M = .4, SE = .24). On average, subjects had a higher percentage of questions answered correctly in Block 2 (M = .5, SE = .17) than in Block 1 (M = .5, SE = .19), $t(23) = -.025$, $p>.05$, Block 3 (M = .4, SE = .21), $t(23) = 1.708$, $p>.05$, and Block 4 (M = .4, SE = .24), $t(23) = 2.574$, $p<.05$.

Comparisons with Block 1 (M = .5, SE = .19), $t(23)$ indicated a significant mean difference with Block 4 (M = .4, SE = .24) (see table 7). On average, subjects-

Table 6

Percentage of Questions Answered Correctly Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Block 1	24	.06	.93	.5	.19
Block 2	24	.24	.95	.5	.17
Block 3	24	.06	.86	.4	.21
Block 4	24	.00	.80	.4	.24

Note: Percentage of Questions Answered Correctly Descriptive Statistics.

-had a higher percentage of questions answered correctly in Block 1 (M = .5, SE = .19) than in Block 3 (M = .4, SE = .21), $t(23) = 1.216$, $p>.05$, and Block 4 (M = .4, SE = .24), $t(23) = 2.396$, $p<.05$.

No significant mean differences were found between Block 3 (M = .4, SE = .21) and any of the other testing time blocks. On average, subjects had a higher percentage of-

Table 7

Percentage of Questions Answered Correctly Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Block 1-Block 2	-,03	23	.98
Pair 2	Block 1-Block 3	1.22	23	.24
Pair 3	Block 1-Block 4	2.40	23	.03
Pair 4	Block 2-Block 3	1.71	23	.10
Pair 5	Block 2-Block 4	2.57	23	.02
Pair 6	Block 3-Block 4	1.44	23	.16

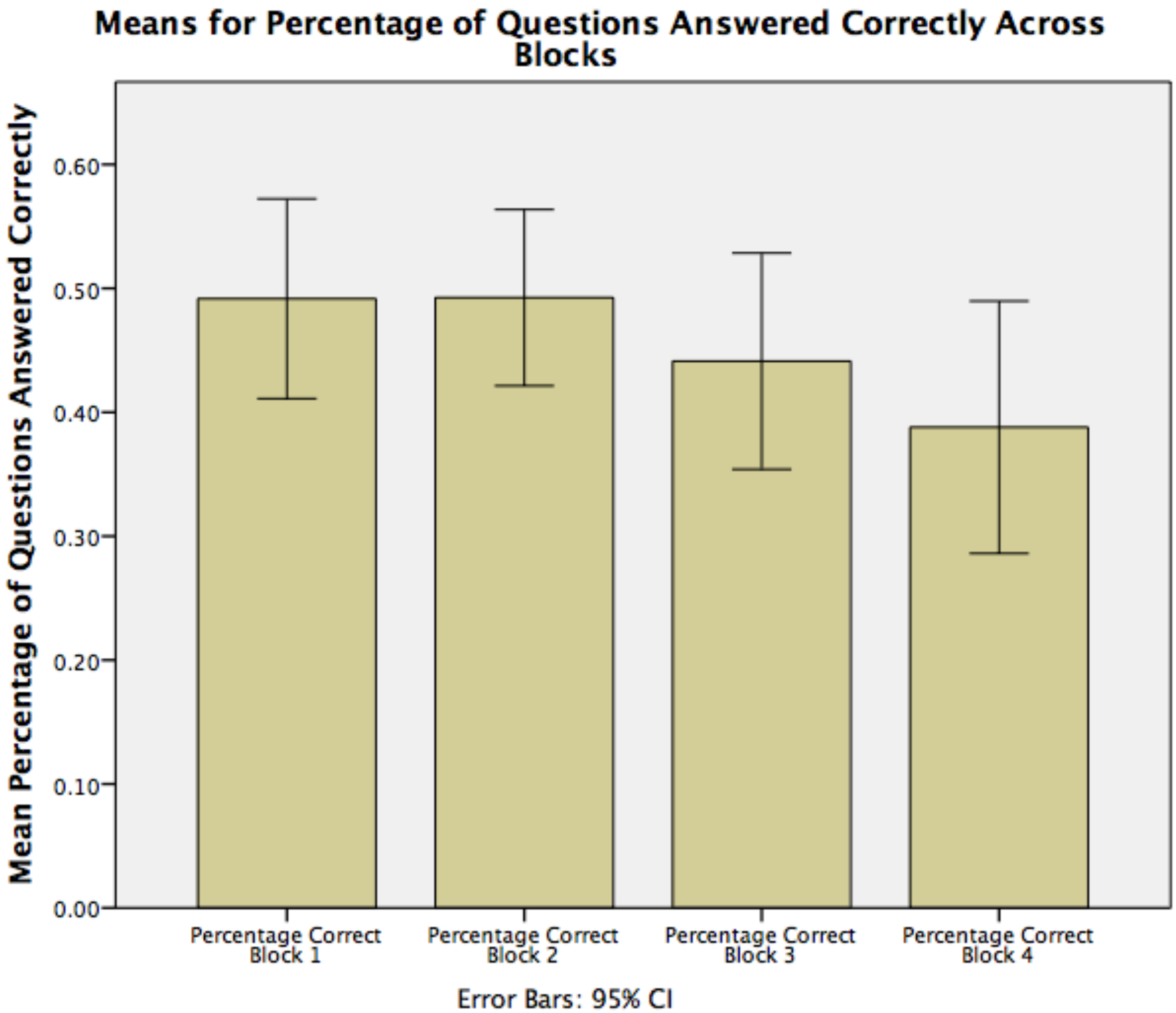
Note: Percentage of Questions Answered Correctly Paired Samples Test.

-questions answered correctly in Block 3 (M = .4, SE = .21), than in Block 4 (M = .4, SE = .24), $t(23) = 1.442$, $p>.05$.

Overall, Block 4 (M = .4, SE = .24) also demonstrated the lowest mean for the percentage of questions answered correctly when compared to all other testing time blocks (see figure 4).

Average Duration of Individual Questions Answered

Results for the analysis of the average duration of individual questions answered indicated that Block 2 (M = 1.0, SE = .29) contained the lowest mean when compared to all other time blocks (see table 8). Significant mean differences were found between Block 2 (M = 1.0, SE = .29) and Block 1 (M = 1.2, SE = .41), and Block 2 (M = 1.0, SE = .29) and Block 3 (M = 1.1, SE = .29) (see table 9). However, no significant mean differences were found between Block 2 (M = 1.0, SE = .29) and Block 4 (M = 1.0, SE = .45).



The above graph demonstrates the mean percentages of questions answered correctly for all subjects in each of the four testing time blocks.

Figure 4. Mean Percentages of Questions Answered Correctly.

On average, subjects had a shorter average duration of individual questions answered in Block 2 (M = 1.0, SE = .29) than in Block 1 (M = 1.2, SE = .41), $t(23) = 5.455$, $p<.05$, Block 3 (M = 1.1, SE = .29), $t(23) = -2.445$, $p<.05$, and Block 4 (M = 1.0, SE = .45), $t(23) = -.853$, $p>.05$.

Table 8

Average Duration of Individual Questions Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Block 1	24	.52	2.16	1.2	.41
Block 2	24	.49	1.55	1.0	.29
Block 3	24	.39	1.76	1.1	.29
Block 4	24	.00	1.93	1.0	.45

Note: Descriptive Mean Differences for the Average Duration of Individual Questions Answered.

Comparisons with Block 4 (M = 1.0, SE = .45) indicated a significant mean difference with Block 1 (M = 1.2, SE = .41). On average, subjects had a shorter average duration of individual questions answered in Block 4 (M = 1.0, SE = .45) than in Block 1 (M = 1.2, SE = .41), $t(23) = 2.413$, $p<.05$, and Block 3 (M = 1.1, SE = .29), $t(23) = .680$, $p>.05$.

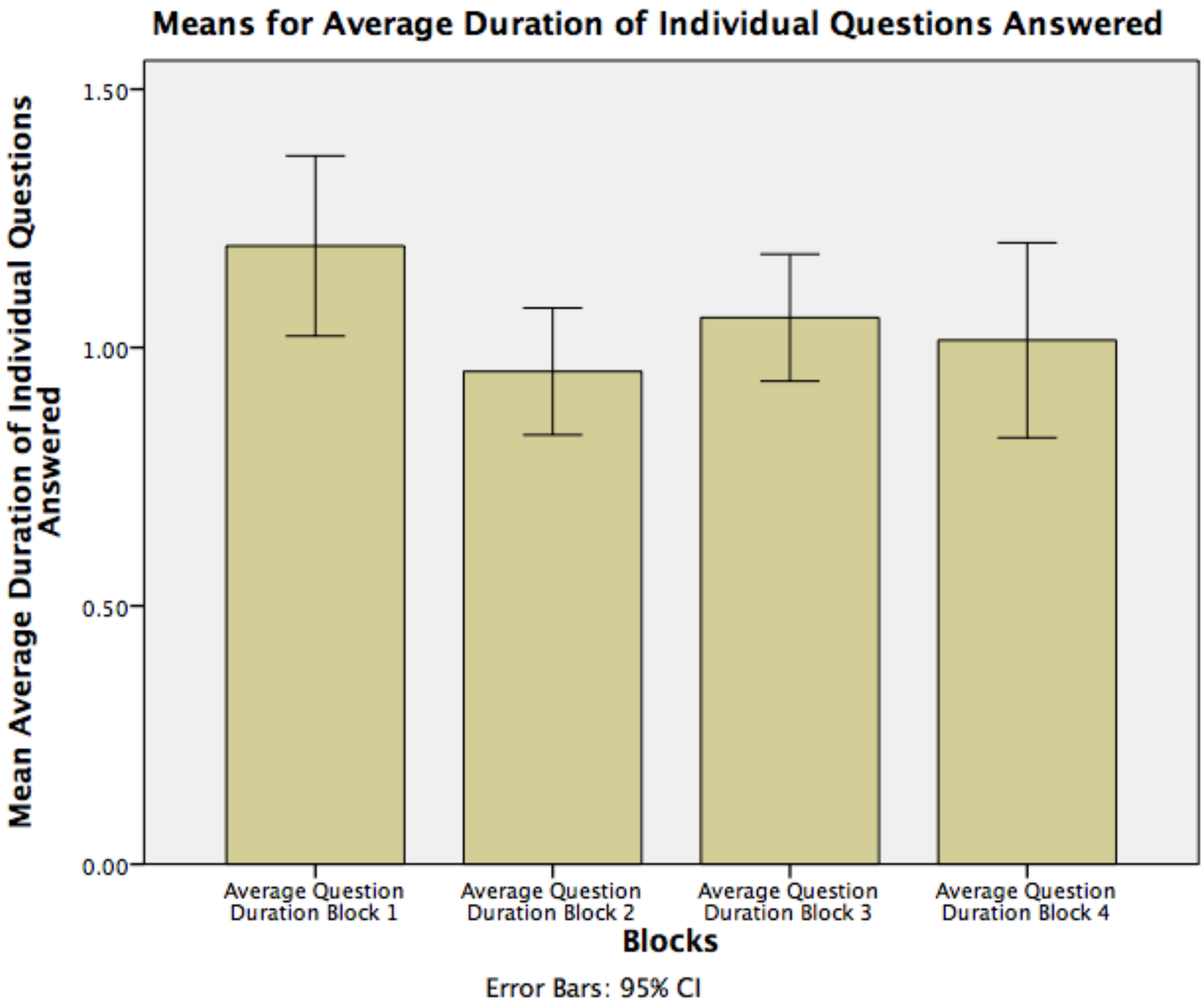
Table 9

Average Duration of Individual Questions Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Block 1 - Block 2	5.46	23	.00
Pair 2	Block 1 - Block 3	2.53	23	.02
Pair 3	Block 1 - Block 4	2.41	23	.02
Pair 4	Block 2 - Block 3	-2.45	23	.02
Pair 5	Block 2 - Block 4	-.85	23	.40
Pair 6	Block 3 - Block 4	.68	23	.50

Note: Pairwise *t*-test results for the Average Duration of Individual Questions Answered.

A significant mean difference was found between Block 3 (M = 1.1, SE = .29) and Block 1 (M = 1.2, SE = .41). On average, subjects had a shorter average question duration in Block 3 (M = 1.1, SE = .29) than in Block 1 (M = 1.2, SE = .41), $t(23) = 2.531$, $p<.05$. Overall, Block 2 presented with the longest mean for average duration of individual questions answered when compared with all other time blocks (see figure 5).



The above graph demonstrates the means for the average duration of time in minutes spent on each individual question. Data is presented for all subjects in each of the four testing time blocks.

Figure 5. Mean Average Durations of Individual Questions Answered.

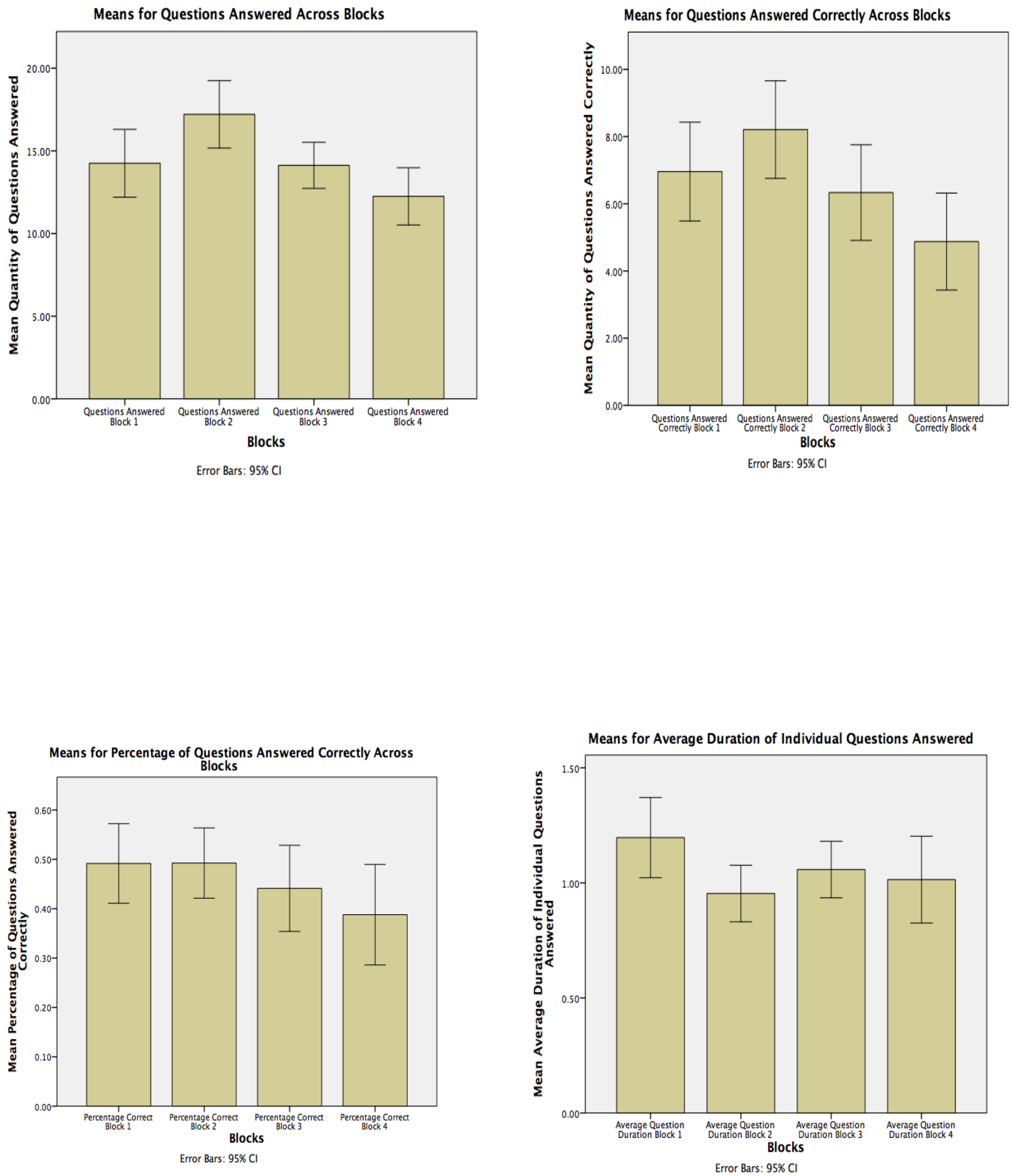
Results Summary

Pairwise *t*-test comparisons between all time blocks across the quantity of questions answered, the quantity of questions answered correctly, the percentage of questions answered correctly, and the average duration of individual questions answered indicate that Block 2 presented with the highest mean of total questions answered, total questions answered correctly, and percentage of questions answered correctly. Block 2 also demonstrates the shortest average duration of individual questions answered. Moreover, Block 2 shows significant mean differences with Block 4 across each of the analysis categories. It appears that Block 4 conveys the lowest means across analysis categories, with the exception of average individual question duration. This presents a ranking of means as Block 2, Block 1, Block 3, and Block 4 across all analysis categories, with the exception of the average duration of individual questions answered in which the ranking of means presents as Block 2, Block 4, Block 3, and Block 1 (see figure 6).

Research Question

"Is there a relationship between music listening and Verbal Reasoning as measured by the Verbal Reasoning portion of the Graduate Record Exam?"

> The results of this study indicated that the presence of subject-identified auditory stimuli is related to a resulting improvement in verbal reasoning testing performance. This relationship is demonstrated across all analysis categories when compared to the silent testing block. These results suggest a positive relationship between the use of subject-identified auditory stimuli and improved verbal reasoning testing performance.



The above figure presents graphs for each of the four analysis categories. Each of these graphs represents mean results for it's category and can be more easily visualized when placed in a single figure.

Figure 6. Mean Results for All Analysis Categories.

CHAPTER V

DISCUSSION

The results of this study support the hypothesis that listening to subject-identified music as an auditory stimulus is associated with an improvement in verbal reasoning testing performance. Music has been demonstrated to increase levels of arousal. It has been suggested in current research literature that this increase in arousal may also result in higher testing scores. Due to this relationship between music as an auditory stimulus and increases in test performance, the outcomes of this study have been interpreted through an arousal framework (Brown & Wilson, 2015; Gadbois & Lints, 2003; Husain, Shellenberg, & Thompson, 2002; Nantais & Schellenberg, 1999; Roth & Smith, 2008). Furthermore the results indicate an improvement in performance in the testing time blocks that received music when compared with testing time Block 4, which did not receive any music. Pairwise *t*-tests indicated that Block 4 maintained the lowest mean scores regarding the quantity of questions answered, the quantity of questions answered correctly, and the percentage of questions answered correctly. Block 1 appears to be an outlier in terms of the order of means expected for an observable decay effect across all testing time blocks. The use of subject-identified stimulating music as an arousal stimulus during testing suggests that an auditory stimulus may provide the necessary effect for improving performance. It would appear that a researcher selected stimulus, such as specific Mozart pieces, are not necessary for this improvement on performance outside of their nature as an auditory stimulus. These findings agree with previous studies testing the relationship between arousal and performance, which suggest that specific pieces of music, among other arousing stimuli specifically selected by the researchers, are not necessary for a performance improving level of arousal to occur (Currie & Perham, 2014; Nantais & Schellenberg, 1999; Hussain, Schellenberg, & Thompson, 2002; Thaut & Hinshaw, 1999; Roth & Smith, 2008).

Analysis 1: Quantity of Questions Answered

Testing time Block 2 contained the highest mean quantity of questions answered and demonstrated significant mean differences when compared with all other testing time blocks (see table 10). It might be expected that testing time Block 1 would contain the highest amount of questions answered, however the results of this study indicate that this is not the case. Answering more questions during testing time Block 2, which has the highest mean quantity of questions answered, may be the result of an adjustment of all, or a portion, of the subjects to the process of the testing. (Yerkes & Dodson, 1908; Han et al., 2013; Baijot et al. 2016; Lambourne & Tomporowski, 2010; Epstude et al., 2013). Subjects may have been adjusting to the testing process during time Block 1, and in doing so reduced the level of novelty experienced by the time that Block 2 commenced. Another possibility is that the administration of the auditory stimulus at the beginning of each testing block, excluding the silent testing Block 4, may act to re-stimulate levels of arousal causing a boost in both levels of arousal and optimal performance.

Table 10

Quantity of Questions Answered Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Block 1	24	7.00	29.00	14.25	4.86
Block 2	24	10.00	31.00	17.21	4.83
Block 3	24	8.00	23.00	14.13	3.30
Block 4	24	.00	19.00	12.25	4.10

Note: Descriptive Mean Differences for the Quantity of Questions Answered.

Conversely, testing time Block 4 contained the lowest mean quantity of questions answered. When using a pairwise *t*-test to compare Block 4 to all other testing time blocks, significant mean differences were found across all blocks with the exception of Block 1. The statistical similarities between Block 1 and Block 4 may be the result of a similar level of performance associated with their levels of arousal, mediated by the presence of subject-identified music (Aidman, Jackson, & Kleitman, 2014; Baijot et al., 2016; Geen, 1984). This may indicate that being in a state of musically mediated hyper-arousal, as well as silence, may generate similar levels of performance. In addition, adjustments to the testing process may have been occurring throughout the sixty-minute testing period, possibly resulting in a lower level of novelty, concerning both musically mediated arousal and testing performance, in Block 4. The lower mean quantity of questions answered in Block 4 may also have been caused by a total of six subjects which answered all of the presented testing questions prior to the end of the sixty-minute testing period, but after the commencement of Block 4 (see table 11).

Table 11

Subjects That Completed Presented Questions Prior to End of Testing Period

Subject	Questions Completed	Duration of Testing
Subject 4	69	54 Minutes
Subject 7	69	52 Minutes
Subject 13	69	54 Minutes
Subject 15	69	51 Minutes
Subject 16	69	52 Minutes
Subject 19	69	53 Minutes

Note: Subjects That Completed All Presented Questions Prior to the End of the Testing Period

A pairwise *t*-test demonstrated no significant mean differences between time Block 1 and Block 3. In addition, Block 1 and Block 3 have similar maximum and minimum quantities of questions answered. It's possible that these similarities may be explained by the presence of similar levels of arousal as mediated by subject-identified music, as previously mentioned (Aidman, Jackson, & Kleitman, 2014; Baijot et al., 2016; Geen, 1984). A combination of the self-regulation of arousal and an adjustment to the testing process, may have resulted in Block 1 and Block 3 presenting with similar responses to subject preferred music, and consequently performance. Testing time Block 3 then falls between Block 2 and Block 4 regarding mean quantities of questions answered. Overall, the mean quantities of questions answered indicate a ranking within the testing time blocks: Block 2, Block 1, Block 3, and Block 4.

Analysis 2: Quantity of Questions Answered Correctly

The results of this analysis demonstrate that testing time Block 2 contained the highest quantity of questions answered correctly. Based on the inferences presented in analysis 1, it could be expected that Block 2 contain both the highest quantity of questions answered as well as the highest quantity of questions answered correctly. Pairwise t-test comparisons express significant mean differences between Block 2 and all other testing time blocks. Again, this is similar to the results of analysis 1. Current research literature may suggest a higher level of hyper-arousal in Block 1, mediated by subject preferred music, which may have played a role in time Block 1 containing the second highest mean quantity of questions answered correctly (Trofimova, 2010; Thayer, 2000: Berridge, Espana, & Schmeichel, 2016; Lambourne & Tomporowski, 2010). In an added similarity to analysis 1, testing time Block 1 and Block 3 did not demonstrate any significant mean difference. It should be considered as well that there is a possibility that the testing time blocks containing higher quantities of questions answered also contain the highest quantity of questions answered correctly. This inference is based upon the possibility that answering a higher quantity of questions, with more opportunities to answer, may also increase the subject's likelihood of answering a higher quantity of questions correctly.

Pairwise *t*-test comparisons between testing time Block 2 and Block 4 resulted in a significant difference of .00 (see table 12). Similar to the quantity of questions answered correctly, Block 1 ranks second among mean quantities of questions answered correctly across the time blocks. Overall, the mean quantities of questions answered correctly indicate a ranking within the testing time blocks: Block 2, Block 1, Block 3, and Block 4.

Table 12

Quantity of Questions Answered Correctly Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	Block 1 - Block 2	-2.55	23	.02
Pair 2	Block 1 - Block 3	.82	23	.42
Pair 3	Block 1 - Block 4	2.67	23	.01
Pair 4	Block 2 - Block 3	2.89	23	.01
Pair 5	Block 2 - Block 4	4.41	23	.00
Pair 6	Block 3 - Block 4	2.43	23	.02

Note: Pairwise t-Test Results for the Quantity of Questions Answered Correctly.

Analysis 3: Percentage of Questions Answered Correctly

Analysis of the percentage of questions answered correctly resulted in significant differences between Block 1 and Block 4, as well as Block 2 and Block 4. These significant differences continue to demonstrate the dissimilarities between testing time blocks receiving subject-identified music and the silent testing time Block 4. The means for the percentage of questions answered correctly corresponds as expected with the results of analysis 2 regarding the quantity of questions answered correctly. Block 2 contained the highest percentage of questions answered correctly followed by Block, 1, Block 3, and Block 4. After analyzing the results of the quantity of questions answered and the quantity of questions answered correctly, the results of the percentage of questions answered correctly would be expected to be similar in pattern and the data appears to confirm this conclusion. The overall performance of subjects across the quantity of questions answered, the quantity of questions answered correctly, and the percentage of questions answered correctly exhibit similar mean differences as well as similar orders when ranked according to their mean results. This could indicate a relationship between these analysis categories and improved levels of performance as mediated by subject-identified music.

Analysis 4: Average Duration of Individual Questions Answered.

Based upon the previously discussed analyses, and the relevant patterns perceived in the data, the observation of Block 2 containing the shortest average duration of individual questions might be expected. Block 2 then, across all analysis categories, exhibits the most improved level of performance when compared to all other time blocks. This is also consistent with the results of the pairwise *t*-tests conducted. Block 4 contains the largest range of average individual question durations, however Block 4 does not demonstrate a significant mean difference with Block 2 (see table 12). Block 4 also contains the lowest mean average for individual question duration across all testing time blocks. The large range of average durations for individual questions answered may suggest a lower level of subject-identified music mediated arousal and motivation. This is further supported by the results of previous analysis categories which demonstrate Block 4 as containing the lowest means for the quantity of questions answered, the quantity of questions answered correctly, and the percentage of questions answered correctly. It should be noted that since two of the subjects in this study completed all of the testing questions before the commencement of testing time Block 4, the mean average for individual question duration for Block 4 may be lower than the results of testing in which all subjects had completed Block 4. A total of six subjects completed all of the presented testing questions prior to the end of the sixty-minute testing period, but after the commencement of Block 4 (see table 11 above).

Block 1 contains the longest mean for average duration of individual questions answered. This might be explained by a combination of the presence of subject-identified music and adjustments to the testing process discussed in analysis 1. This period of self-regulation and novelty adjustment could help to better explain the longer period of time required by subjects to answer individual questions. Overall, the results indicate that testing time Block 2 contained the shortest mean for average duration of individual questions answered, followed by Block 4, Block 3, and Block 1.

Table 13

Average Duration Ranges

	N	Minimum	Maximum
Block 1	24	.52	2.16
Block 2	24	.49	1.55
Block 3	24	.39	1.76
Block 4	24	.00	1.93

Note: Duration Ranges for Average Duration of Individual Questions Answered.

Conclusions

Overall, these significant differences indicate a ranking in performance quality across Block 2, Block 3, and Block 4 with Block 1 typically ranking second (refer back to figure 5). The only category in which this ranking is different is the average duration of individual questions answered. This duration category indicates that subjects in Block 2 spent the least amount of time answering questions, immediately followed by Block 4. This suggests that Block 4 ranks last concerning testing performance. Subjects spent the second least amount of time on individual questions in Block 4 as well, which suggests a lack of subject-identified music resulted in a potential lack of personal motivation, or energy, to complete the testing tasks accurately (Zajonc's arousal and confluence theories, 2006; Forster & Davis, 1994; Han et al., 2013; Theories of motivation, 2006). The lack of significant mean differences between Block 1 and Block 3 across all categories, with the exception of average question duration, may also indicate the presence of a similar level of optimal performance mediated by subject-identified music.

It’s possible, based on the current research literature, that the presence of a subject-identified musical stimulus in Block 1 activated the subjects’ central noradrenergic systems. This is the system responsible for regulating an individual’s levels of arousal (p. 213) (Berridge, Espana, & Schmeichel, 2016). The consequences of this regulation may be visible in the improved performance means of subjects in Block 2 compared to Block 1. (Trofimova, 2010; Thayer, 2000: Berridge, Espana, & Schmeichel, 2016; Lambourne & Tomporowski, 2010)**.** This may also help to explain why Block 1 is outside of the expected position for a full quantitative decay effect; levels of musically mediated arousal during testing time Block 1 may have been higher than desired for optimal performance, self-regulated, and positioned into a more optimal level for the commencement of testing time Block 2.

Finally, these results would seem to indicate that the most ideal levels of improved performance could be found in testing time blocks which received an arousing auditory stimulus, and that the effects on improved performance decreases over time. The scope of this study remains specific to the relationship between subject-preferred music as an arousing stimulus and cognitive performance, and acts to open the door for future research into arousal and performance across a number of domains. It is important therefore, to also note that the effects of self-regulation on this musically mediated arousal appear to be most observably present in the relationships between Block 1 and the other testing time blocks. The impacts of this self-regulation suggest that a subject-identified musical stimulus, in this case possibly brought on by the initial administration of music and the novelty of testing, could be subjectively adjusted to an optimal level of performance over time.

Limitations

This study contains a number of limitations, which require noting. The quantity of questions presented for testing needs to be increased. As noted in the above discussion of analysis, two subjects completed all of the presented testing questions prior to the commencement of the fourth testing time block. Although the questions presented during testing were taken from the same reading comprehension portion of the GRE, and in addition were analyzed to create a more homogenous quality, the different lengths of the reading portions may have affected the average duration of individual questions answered. Testing time Block 4, the silent time block, was presented during the final 15 minutes of the 60-minute testing period. Additional fatigue from the previous 45 minutes of testing may have played a factor in the level of arousal experienced by the subjects.

The testing program itself created slightly different lengths of time for each of the testing time blocks. This was due to the automatic administration of the auditory stimulus. The new testing time block, along with the administration of the auditory stimulus, would not begin until the final question administered for the previous testing time block was completed. As a result, each testing time block is of very slightly different duration across all subjects. Due to this difference in testing duration, it was difficult for the researcher to exactly gauge the end of the testing period. As a result, 2 subjects were interrupted during their final 2 questions of testing time Block 4. These questions were removed from the final analysis of data.

Suggestions for Future Research

Modifications to certain aspects of the methodology of this study may prove useful for future research. The quality of the questions presented requires complete homogenization. It is the recommendation of this researcher that all questions contain the same number of lines in it's reading portions, as well as contain the same method of answering questions such as "fill in the blank." It is also recommended that the quantity of questions presented during testing be increased with the intention of having more questions available for presentation than subjects may be able to answer. It may also be useful to place the silent testing time block earlier in the testing period to avoid any unwanted fatigue variables. In addition variations on the timing of the administration of arousing stimuli during testing may present future researchers an improved method of monitoring a potential decay effect.

Understanding arousal and it's relationship with cognitive performance could be useful for the improvement of clinical treatment administered by health professionals, and could also be considered in terms of it's effects on standardized testing practices in general. Investigation into the effects of arousing stimuli in a client's environment could be useful in assessing whether or not a client is performing to their best ability, or if their comprehension and performance are impacted by these arousing stimuli. Music therapists may benefit from better understanding the effects of arousal and it's corresponding potential decay effect; assisting them in better utilizing music interventions in both the timing of their administration of music, and the subjective arousal level of their clients. Future research into the potential contributions of self-regulation and subjective adjustments to the novelty of a stimulus in arousal states, could also help to guide future clinicians in determining levels of variability required in their treatment in order to achieve a maximal level of cognitive performance in their clients. This current research may play a role in the development a research foundation for future research into the relationships between arousal states and cognitive performance necessary for the previously suggested expansions to occur.

APPENDIX A

RECRUITMENT FLYER

VOLUNTEERS NEEDED

For music and cognitive arousal research study

Flexible scheduling is available

Compensation	***Requirements:***
Compensation will be provided in the form of a $40.00 gift card.	1. Must speak English as a first language 2. No more than one year of formal music training 3. Commitment for one research session 4. Between the ages of 18 and 65 5. No hearing impairments 6. You must be a WMU student

For more information contact :
Meghan Feeman, MT-BC
meghan.e.feeman@wmich.edu
Ian Kells, MT-BC, NMT
ian.t.kells@wmich.edu

MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309	MUSIC RESEARCH STUDY (630) 930-0309

APPENDIX B

RECRUITMENT SCRIPT

E-mail Script 1

Hello,

Thank you for your interest in participating in this research study. This study will analyze how individuals perform during cognitive tests when music is implemented by analyzing physiological response and test accuracy. Your participation will include one testing period, which will take no longer than 60-minutes to complete. You will receive a $40 gift card for your participation.

If you are interested, please fill out an availability form and attach it to your E-mail. Once we have received the necessary document, we will provide you with specific information on where and when we will meet to review an HSIRB consent form.

Please contact me if you have any questions.

Thank you,

Ian Kells, MT-BC, NMT
Music Therapy Masters Student
Western Michigan University

Meghan Feeman MT-BC
Graduate Assistant
Music Therapy
Western Michigan University

APPENDIX C

RECRUITMENT SCRIPT

E-mail Script 2

Hello,

Thank you for your availability form, you have been scheduled for Day, Date at Time. The study will take place at the *BRAIN Lab* on Western Michigan University's campus in the College of Health and Human Services Building in room 2017.

This initial meeting is to review the HSIRB consent form and discuss all details of the research project. You will not begin the study during this meeting, but will be scheduled for another time to participate, if interested. This meeting should take about 10 minutes.

Please confirm that this day, date, and time will work for your schedule and let me know if you have any questions.

Thank you,

Ian Kells, MT-BC, NMT
Music Therapy Masters Student
Western Michigan University

Meghan Feeman MT-BC
Graduate Assistant
Music Therapy
Western Michigan University

APPENDIX D

RECRUITMENT SCRIPTS

Phone Script

Hello,

Thank you for your interest in participating in this research study. This study will analyze how individuals perform during cognitive tests when music is implemented by analyzing physiological response and test accuracy. Your participation will include one testing period, which will take no longer than 60-minutes to complete. You will receive a $40 gift card for your participation.

If you are interested, please E-mail either Ian Kells at ian.t.kells@wmich.edu or Meghan Feeman at Meghan.e.feeman@wmich.edu to receive an availability form. Once we have received the availability form, we will provide you with specific information on where and when we will meet to review an HSIRB consent form. Do you have any questions?

Thank you.

APPENDIX E

MUSIC PREFERENCE FORM

For this research study, it is requested that you provide the researchers one song that you find personally motivating. This will be defined as a song that is upbeat, that you greatly enjoy, and that induces a strong emotional response, but neither relaxes nor over-stimulates you. You must provide the researcher with the song selection before participating in the study. It is also requested that the song only last 3 minutes. If your song selection is shorter than 3 minutes you may not choose it. If the song is more than 3 minutes long, please specify which 3 minutes you would like to be used (for example 0:00-3:00 or 1:35-4:35).

Song Title:

Artist:

Specified Time Range:

APPENDIX F

Participant Song Choices

	Artist	Song Title	Genre
1	Silversun Pickups	“Lazy Eye”	Alternative
2	Odesza	“Kusanagi”	Electronic
3	Whiney	“Golden Days”	Alternative
4	M83	“Midnight City”	Alternative
5	Ookay	“Thief”	Electronic
6	Thomas Rhett	“Star of the Show”	Country
7	Ed Sheeran	“Shape of You”	Pop
8	Luke Bryan	“Fast”	Country
9	Fergie	“Fergalicious”	Pop
10	Rise Against	“Savior”	Hardcore
11	Kelly Clarkson	“Stronger”	Pop
12	A Day to Remember	“Sine U Been Gone”	Metal
13	Arcade Fire	“Wake Up”	Alternative
14	Pink	The Great Escape	Pop
15	Journey	“Don’t Stop Believing”	Classic Rock
16	Bruno Mars	“That’s What I Like”	R&B
17	Journey	“Don’t Stop Believing”	Classic Rock
18	Faith Evans and Twista	“Hope”	Hip Hop
19	Born of Osiris	“Machine”	Metal
20	Bruno Mars	“24k Magic”	R&B
21	Madonna	“Into the Groove”	Pop
22	Darius Rucker	“Alright”	Country
23	Oasis	“Live Forever”	Alternative
24	Rick Springfield	“Jessie’s Girl”	Rock

APPENDIX G

CONSENT FORM

Western Michigan University
Department Music Therapy

Principal Investigator: Edward Roth, MM, MT-BC
Student Investigator: Ian Kells, MT-BC
Title of Study: The effect of auditory stimuli on test performance: Testing the arousal hypothesis

You have been invited to participate in a research project titled " *The effect of auditory stimuli on test performance: Testing the arousal hypothesis*." This project will serve as Ian Kells' thesis for the requirements of the Masters of Music Therapy. This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?

The purpose of this study is to investigate preferred music listening, auditory arousal, and its potential effect on an individual's performance on certain testing criteria.

Who can participate in this study?

This study is open to individuals between the ages of 18-65 who have had less than one year of formal music training. 24 subjects will participate in the study and our inclusionary criteria for participation in the study are as follows:

- Must be between the ages of 18 and 65 years old
- Must have less than one year of formal music training
- A Western Michigan University student
- Must speak English as your first language
- Must not have any hearing or visual impairment
- No deficits in cognition or reading abilities

Exclusionary criteria include individuals younger than 18 and older than 65 years old, as well as those who have hearing impairments or more than one year of formal music training. All participants must also speak English as their first language. All assessment of this information will be made at the discretion of the investigators utilizing a document for identifying the above listed information and requiring a signature from the participant for verification.

Where will this study take place?

Data collection for this study will take place in the Brain Research and Interdisciplinary Neurosciences (B.R.A.I.N.) Lab, room #2017, in the Health and Human Services building at Western Michigan University.

What is the time commitment for participating in this study?

This study requires the subjects to participate in one sixty-minute research session.

What will you be asked to do if you choose to participate in this study?

If you choose to participate in this study you will be instructed to provide a preferred song that you find personally motivating or energizing. There will be no limitation on preferred song choice, except for the duration of the song, which will need to be three minutes. We will use this song during the data collection process.

Once the data collection process begins, you will be asked to wear headphones and an Electro-dermal Activity (EDA) monitor on the write of your non-dominant hand and electrodes on the distal pads of third and fourth digits of your non-dominant hand to monitor physiological arousal. These items will be worn for the duration of the testing period. You will be instructed to place a pair of headphones on your head. A set of recorded instructions will be relayed to the you via the headphones, and you will be directed to adjust the volume of the audio, if needed, during this time. After the recorded instructions have finished being relayed, the EDA monitor will be applied. You will then be given brief verbal instructions from the investigators so that you will know how to take the exam. The test itself will contain a portion of the Graduate Records Exam (GRE) Verbal Processing Practice Exam using the MATLAB platform on a computer provided by the WMU B.R.A.I.N. Lab.

During the exam you may hear the preferred song you have chosen at various times. The test will be timed and will stop after sixty minutes. The test will be monitored for accuracy, so the speed at which the test is completed will not be important.

What information is being measured during the study?

This section will describe the measurements that we are going to take during your participation in the study.

Two outcomes will be measured during this study:

- The accuracy of questions answered
- The level of physiological arousal.

MATLAB will be used to monitor the accuracy of the answers provided by you for each of the questions on the test. Physiological arousal will be measured using the EDA monitor that will be placed on your pointer finger at the beginning of testing.

What are the risks of participating in this study and how will these risks be minimized?

The risks associated with participating this study include fatigue due to the longer amount of time required to participate in the exam. There may also be slight discomfort due to wearing headphones and an EDA monitor for the full duration of sixty minutes during testing.

What are the benefits of participating in this study?

There are no known direct benefits to you for participating in this study. Your participation may contribute to the knowledge base regarding the implications of using music and auditory stimulation for improving performance on certain tasks.

Are there any costs associated with participating in this study?

There are no costs associated with participation in the study, with the exception of sixty minutes of time.

Is there any compensation for participating in this study?

There will be a compensation of $40.00 in the form of a gift card provided to each participant upon completion of the study. This study may also qualify for those students who may be required to participate in a study as part of their course work.

Who will have access to the information collected during this study?

Only the two student investigators and the principal investigator will have access to the information gathered during this study. All data collected will be stored in a password-protected computer file, on a password-protected computer. All forms will be stored in a locked filing cabinet, and both forms and electronic data will be located in the locked WMU B.R.A.I.N. Lab.

The identities of all participants will be coded using a set of numbers in chronological order to maintain personal confidentiality. This information will be stored in a password-protected computer file, on a password-protected computer, in the locked WMU B.R.A.I.N. Lab.

What if you want to stop participating in this study?

You can choose to stop participating in the study at anytime for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically or personally if you choose to withdraw from this study with the exception of your loss of monetary compensation.

The investigator can also decide to stop your participation in the study without your consent.

Should you have any questions prior to or during the study, you can contact primary student investigator, Ian Kells, at (630) 930-0309 or ian.t.kells@wmich.edu, the co-student investigator, Meghan Feeman, at 317-437-8418 or meghan.e.feeman@wmich.edu, or the primary faculty advisor, Edward Roth, at (269) 387-5415 or edward.roth@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions or problems arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

____

Please Print Your Name: ____

_____________________________ _________________________

Participant's signature Date

APPENDIX H

Availability Form

Please provide the times you are available by circling the corresponding time block. You do not need to provide any personal information, only circle the available times.

Name:

	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
8:00					
9:00					
10:00					
11:00					
12:00					
1:00					
2:00					
3:00					
4:00					
5:00					
6:00					

APPENDIX I

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: October 11, 2016

To: Edward Roth, Principal Investigator
Ian Kells, Student Investigator for thesis
Meghan Feeman, Student Investigator

From: Amy Naugle, Ph.D., Chair Amy Naugle

Re: HSIRB Project Number 16-09-27

This letter will serve as confirmation that your research project titled "The Effect of Auditory Stimuli on Test Performance: Testing the Arousal Hypothesis" has been **approved** under the **expedited** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., ***you must request a post approval change to enroll subjects beyond the number stated in your application under "Number of subjects you want to complete the study***)." Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: October 10, 2017

1903 W. Michigan Ave., Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276
CAMPUS SITE: 251 W. Walwood Hall

APPENDIX J

RECEIVED
SEP 07 2017
H.S.I.R.B.
Western Michigan University

WESTERN MICHIGAN UNIVERSITY
Human Subjects Institutional Review Board
WMU Mail Stop: 5456 Phone: (269) 387-8293

APPLICATION FOR CONTINUING REVIEW OR FINAL REPORT FORM

In compliance with Western Michigan University's policy that "the HSIRB's review of research will be conducted at appropriate intervals but not less than once per year," the HSIRB requests the following information:

PROJECT INFORMATION

PROJECT TITLE: The Effects of Auditory Stimuli on Test Performance: Testing the Arousal Hypothesis
HSIRB Project Number: 16-09-27 Date of Last Approval (Initial or Continuing Review): 10/11/16

Previous level of review: ☐ Full Board Review ☒ Expedited Review ☐ Administrative (Exempt) Review

INVESTIGATOR INFORMATION

PRINCIPAL INVESTIGATOR OR ADVISOR
Name: Edward Roth
Department: MUSIC Mail Stop: 5434 Electronic Mail Address: edward.roth@wmich.edu

CO-PRINCIPAL OR STUDENT INVESTIGATOR
Name: Ian Kells
Department: Mail Stop: Electronic Mail Address: ian.t.kells@wmich.edu

CO-PRINCIPAL OR STUDENT INVESTIGATOR
Name: Meghan Feeman
Department: Mail Stop: Electronic Mail Address:
meghan.e.feeman@wmich.edu

CURRENT STATUS OF RESEARCH PROJECT

Please answer questions 1-5 to determine if this project requires continuing review by the HSIRB.

1. Has subject recruitment begun? If no, please provide an explanation ☒Yes ☐ No
2. Is the project closed to recruitment of new subjects?
   ☒Yes (Date of last enrollment:4/13/1) ☐No (Project must be reviewed for renewal.)
3. Have all subjects completed research related interventions?
   ☒Yes ☐ Not Applicable ☐No (Project must be reviewed for renewal.)
4. Has long-term follow-up of subjects been completed?
   ☐Yes ☒ Not Applicable ☐No (Project must be reviewed for renewal.)
5. Has analysis of data been completed?
   ☒Yes ☐No (Project must be reviewed for renewal.)

- If you have answered **"No" to ANY** of the questions above, you must apply for **Continuing Review**.
- ***If you need to make changes in your protocol, please submit a separate memo detailing the changes that you are requesting.***
- If you have answered **"Yes" or "Not Applicable" to ALL** of the above questions, the project may be closed.
  If the project is closed please use this form for the "Final Report."

☒ **Application for Continuing Review** ☐ **Final Report**

HSIRB Project Number: 16-09-27

6. Are there any changes in study personnel (add or remove investigators) not previously reported to the HSIRB? ☐Yes ☒No
   If you need to add an investigator, provide details on an "Additional Investigator(s) Form" (available at http://www.wmich.edu/research/forms/complianceforms.html).
   To remove an investigator submit a memo to the HSIRB detailing the change.

7. Since the last approval (initial or continuing review) has there been any modifications or additions to the protocol, not previously reported to the HSIRB to with respect to the following?
   a. Procedures ☐Yes ☒No
   b. Subjects ☐Yes ☒No
   c. Design ☐Yes ☒No
   d. Data collection ☐Yes ☒No

8. Has any instrumentation been modified or added to the protocol that has not already been approved by the HSIRB? ☐Yes ☒No
   If **yes**, attach new instrumentation and a memo indicating the modifications made.

9. Are there changes to the consent/assent form not previously reported to the HSIRB? ☐Yes ☒No
   If **yes**, attach new consent/assent form and a memo indicating changes made.

Verification of Consent Procedure: *Provide copies of the whole consent documents signed by the last two subjects enrolled in the project. Cover the signature in such a way that the name is not clear but there is evidence of signature. If subjects are not required to sign the consent document, provide a copy of the most current consent document being used.*

SUMMARY OF THE RESEARCH

10. Have there been any adverse events, unexpected or unanticipated study-related problems which have not previously been reported to HSIRB? If **yes**, provide details on an attached sheet. ☐Yes ☒No

11. Is there new risk or benefit information not previously reported to the IRB? ☐Yes ☒No
    If **yes**, attach a memo indicating the risk or benefit information.

12. Summarize progress of the research using non-technical language that can be easily understood by a reviewer outside the discipline. Please use complete sentences to briefly summarize the research since the last review (initial or continuing). **The purpose of this study was to test the relationship between auditory stimuli, in the form of subject preferred music, and it's effect on test performance as measured by the percentage of questions answered correctly and the amount of time taken to answer questions on the verbal reasoning portion of the GRE. A total of 29 subjects were recruited for testing, but due to some technical errors in data collection, the data for 24 subjects was considered valid for analysis. The initial sample size determined necessary for validity was 24 subjects. Data analysis is currently in progress concerning the percentage of questions answered correctly, the amount of time taken by the subjects to answer these questions, and their potential relationships to auditory stimulation in the form of subject preferred music.**

13. List and describe any complaints about the research study since the last HSIRB review (initial or continuing review); include action taken to resolve the complaints (If not applicable, type NA). **NA**

14. List any voluntary withdrawals by participants from the study since the last HSIRB review (initial or continuing review); include action taken as a result of the withdrawals. (If not applicable, type NA). **NA**

HSIRB Project Number:

SUBJECT RECRUITMENT

15. Have research subjects been enrolled (or subject records, specimens, etc. obtained)? ☒Yes ☐No
Provide a letter of explanation if no research subjects have been enrolled (or subject records, specimens, etc. obtained).

16. Total number of subjects approved in original protocol: **100**

17. Total number of subjects enrolled so far: **29**
If applicable: Number of subjects in experimental group: **NA** Number in control group: **NA**

18. Estimated number of subjects yet to be enrolled: **0**

Please remember to include a clean original of the consent documents to receive a renewed approval stamp.

INVESTIGATOR'S ASSURANCE

I certify that the information contained in this HSIRB Application for Continuing Review and all attachments are true and correct. I certify that the research has been and will continue to be conducted according to the protocol as approved by Human Subjects Institutional Review Board.
I agree that I will not implement any changes in the protocol until such changes have been reviewed and approved by HSIRB. If, during the course of the research, unanticipated risks or harm to subjects are discovered, I will report them to HSIRB immediately. I agree to follow all applicable federal regulations, guidance, state and local laws, and university policies related to the protection of human subjects in research, as well as professional practice standards and generally accepted good research practices for investigators

If this is a FINAL REPORT you may return the form electronically (signature is not required).

Ed Rott — 9-6-17
Principal Investigator/Faculty Advisor Signature — Date

Ian Kells — 8/28/2017
Co-Principal or Student Investigator Signature — Date

Meghan Feeran — 9/7/17
Co-Principal or Student Investigator Signature — Date

Approved for a one-year extension by the HSIRB:

Amy Naugle — 9/11/17
HSIRB Chair Signature — Date

Revised 06/2013 WMU HSIRB (all other copies obsolete).

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