THE RELATIONSHIP OF RHYTHMIC AND MELODIC PERCEPTION WITH BACKGROUND MUSIC DISTRACTION IN COLLEGE LEVEL STUDENTS

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ABSTRACT

This study investigated relationships among the ability to audiate musical stimuli, background music condition, familiarity, gender, general academic achievement, age, and frequency of use on the level of distraction caused by background music. Eighty-four general college students were given the *AMMA*. The students were divided into three equal groups and given three cognitive tests (*Nelson-Denny Reading Test*/*D2 Test of Attention*/Spatial Ability Test) under three background music conditions (no music/sedative music/stimulative music). A counterbalance design was followed. Orchestral background music was used during the treatment. The findings suggest that general academic achievement had a significant positive relationship with reading comprehension, spatial ability, and concentration regardless of background music condition. Furthermore, the sedative music condition had a significant negative relationship on measures of concentration. These findings are discussed in relation to previous studies. Implications for educators are given.

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CHAPTER ONE

Introduction

Music is everywhere. At the dawn of the twenty-first century, we have more portable technology and ease of access to the music of our choice than any time in the history of the world. There is music in our churches, our malls, our elevators, our houses, our cars and even our classrooms. Recordings have moved from bulky vinyl records and erasable magnetic tapes, through digital compact disks, to tiny electronic files that can be played on multiple devices such as large stereo systems or small personal mp3 players.

The ubiquitous nature of today's music has placed it in situations never thought of in generations past. Although the popularity of music lends credence to its almost universal acceptance and enjoyment, does this constant use of music in the background or foreground have an effect on our society? Does it enhance or hinder our productivity? What is the impact on education? Is this merely a preoccupation with personal enjoyment, or does music have any beneficial effects on our lives? These questions are much too broad to be covered in a single research paper. Therefore the current study will focus on the effects of background music in education.

Furnham and Stanley (2003) posited that the availability, affordability and mobility of music today would likely escalate in its use during study time. In fact, a casual walk through most university libraries will find an increasing number of students studying with ear buds or headphones. This corresponds with the findings of

Beentjes, Koolstra and van der Voort (1996) in which 99% of the respondents reported working on homework with background music playing.

Along with the increase in personal use of background music, parents and teachers have likewise added music to the ambient noise of homes and classrooms. With the coining of the phrase “Mozart Effect” and its subsequent findings, there has been an explosion in interest on the possible beneficial effects of background music on intelligence. Industries have been created to supply parents with brain enhancing music and videos. Even state governments have proposed sending appropriate music home from the hospital for every child born in their state. Although many follow-up studies have failed to replicate the effect, never-the-less parents and teachers are playing background music for several hours during the day in the hope of giving their students every advantage possible.

James (2004) described the following ways he uses music in the classroom: a) as a cue to start class and to start and end breaks, b) as noise masking during small group discussion to prevent awkward silence, and c) as background during in-class reading or writing assignments. Although these are only ad hoc observations, he did not claim that the music makes his students smarter; rather he stated that the judicious use of music relaxes students, enhances the classroom atmosphere, promotes dialogue and engages students in the learning process. On class evaluations his students were asked if, “The use of music enhanced the classroom environment”. Out of 237 responses: 94.1% chose strongly agree or agree, 2.5% chose strongly disagree or disagree, and 3.4% chose undecided. The use of background music in classrooms and study time beg the following questions: “Are some students negatively affected by the background music?” “In our rush to help, are some students harmed?” These questions may be answered by analyzing the effects of background music on student performance.

Individuals listen to music at different levels of understanding (based on education) and in different ways (based on music aptitude, personality traits and influence of education). For example, music education helps the individual learn to label instrument timbres, identify basic form and texture, and identify the melody. Personality traits and music aptitude may influence the way individuals naturally listen to music. Some listen to music at the surface level, where music is perceived as a general wash of sound. Others hear subtle changes in tonality, texture, rhythm, etc. Does the ability to hear these subtle changes in music cause individuals to be more distracted in the presence of background music? Are individuals without this ability less likely to be distracted by background music? Which cognitive tasks are more likely to be disadvantaged in the presence of background music? These questions form the basis for the current research.

Student performance is affected by several factors including: self-control, mood, focus of attention, arousal, and intelligence. In the next chapter we will examine research demonstrating the effects of background music on mood, behavior, focus of attention, and arousal in relation to task performance.

CHAPTER TWO

Review of the Literature

There has been great interest throughout the last century over the positive and negative effects of background music. As early as 1943, Kirkpatrick wrote a literature review of World War II and pre-war era studies on the use of background music to increase factory production. Henderson, Crews, & Barlow (1945) studied background music distraction on reading comprehension. E. Thayer Gaston's leadership in the 1940s on the new field of music therapy expanded research into areas of anxiety reduction, effects on behavior, physiological changes, mental arousal and mood (Johnson, 1981; Radocy & Boyle, 1997).

One of the main focuses of research continues to be the area of task performance. Many people seem to benefit from the presence of background music, while others are hindered by it and are unable to function efficiently. It is the purpose of this study to investigate empirically if the ability to hear subtle rhythmic and melodic variations in music is one possible factor in explaining why some people are distracted where others benefit. To this end the following review of literature focuses on empirical and quantitative research of background music relative to: (a) Physiological and behavioral effects, (b) Emotional effects, (c) Cognitive effects, and (d) Personality effects.

Physiological and Behavioral Effects

Researchers have noted several physiological effects music has on the human body. The heart rate of some individuals slows down to match the tempo of background music. This is a process called “entrainment” (Giles, 1991). A program of accelerated learning called *Superlearning* was developed around this process. This system involves the use of soft background music to slow heart rate, relax minds and bodies, which in turn enables students to learn faster, thus affecting task performance (Ostrander & Schroeder, 1979).

Savan (1999) found that the physiological effect was not limited to heart rate. Students with special educational needs and emotional and behavioral difficulties listening to certain Mozart orchestral compositions exhibited a reduction in blood pressure and body temperature as well as a lowered heart rate. In an earlier study (Savan, 1998), it was suggested that soothing music might stimulate an area of the brain to trigger a set of chemicals to be produced that would suppress the production of adrenaline and corticosteroids. These corticosteroids have been identified by Smith (1996) as physiological markers of high arousal and stress, which hinder learning. It is interesting to note that there was a marked improvement in student behavior accompanying the drop in physiological parameters during the background music condition (Savan, 1999).

Behavior management is an area of intense interest particularly in schools where it affects learning and safety. Music is an easy and inexpensive solution that may create dramatic results in certain situations. Background music studies have demonstrated that: first and second grade students calm down more rapidly after recess in the presence of familiar music with slow tempos around sixty beats per minute (Giles, 1991); soft music reduced the average out-of-seat and talk-out behaviors in the classroom and on the school bus (Campbell, 1996; and McCarty, McElfresh, Risce, & Wilson, 1978); elementary school children demonstrated more desirable social behavior with background music present than the group that had no music present (Kotwal, 1995); interventions by school authorities dropped 65% compared to no music (Giles, 1991); and there was less variability in student behavior compared to no music (Campbell, 1996).

Other studies have demonstrated that the genre of the music has an effect on behavior. Classical instrumental music resulted in a reduction of disruptive incidents, whereas the introduction of rock music with lyrics resulted in an increase of disruptive incidents (Ausbrooks, 1994; Harris, Bradley, & Titus, 1992). Also, the use of easy listening background music was found to significantly increase the on-task behavior of 5^{th} grade boys (Davidson & Powell, 1986).

Similar research is devoted to the efforts of music on individuals with mental and/or emotional disorders. Results indicate that background music is detrimental to cognitively impaired elderly nursing home residents in performing basic functional tasks such as getting a drink, folding laundry and setting a table (Elm, Warren, & Madill, 1998). They suggested that the external stimulus was too high for cognitively impaired individuals, contributing to anxiety and confusion. Conversely in a different study, patients with severe dementia exhibited a decrease in aggressive and agitated behavior in the presence of background music. There was a corresponding reduction in disruptive vocalizations. Further, when the caregivers sang, there was an increase in patient understanding and cooperation where before there was only minimal compliance (Götell, Brown, & Ekman, 2002). These studies show the benefits of background music in the assisted living environment.

Likewise, studies involving children described as hyperactive or emotionally disturbed have been shown to benefit from background music in the classroom. Soothing background music decreased undesirable activity (Chalmers, Olson, & Zurkowski, 1999; Gregoire, 1984) and led to increased performance on a math test (Hallam & Price, 1998; Hallam, Price, & Katsarou, 2002). Two possible explanations for this effect have been suggested: background music acted to mask extraneous stimuli that led to reduced off-task behavior (Burleson, Center, & Reeves, 1989); and the effects of music on performance seem to be controlled by its effects on arousal and mood (Hallam, Price, & Katsarou, 2002; Schellenberg, 2005). The effects of background music on mood will be discussed in the next section.

Emotional Effects

Positive Mood Enhancement

It is conventional wisdom that music effects mood and that positive mood enhances performance. Many studies have been conducted to support or contradict these common assumptions.

It appears that various types of music affect mood and arousal differently (Gabrielsson, 2001; Schellenberg, Nakata, Hunter & Tamoto, 2007). Positive mood may facilitate cognitive task performance, whereas, negative mood can disrupt performance (Isen, 2000, 2002). Therefore the ideal music to play for children should reduce arousal and induce positive mood (Thompson, Schellenberg, & Husain, 2001).

The challenge is to determine which qualities of music will lead to these benefits for the majority of students without hindering the rest.

Obese children and adolescents ran significantly longer on a treadmill test when distracted by their favorite music (Bourdeaudhuij, Cormbez, Deforche, Vinaimont, Debode, & Bouckaert, 2002). Using music during writing and discussion helps mood (Jenson, 1996). Chalmers, et al. (1999) reported that students preferred background music played in the lunchroom to silence. Interestingly bright students preferred taking tests with music and found it relaxing while non-bright students found the music distracting (Fogelson, 1973). However, music did not affect the attitude of individuals towards bowling (Beasley, 1981). Students learning to dribble a basketball overwhelmingly preferred to have background music played during the activity (Kotwal, 1995). Participants in a background music study (Flowers, 2005) reported the listening component as the high point of their day and looked forward to it all morning. Boal-Palheiros and Hargreaves (2004) found that children are less likely to sit and listen to music at home but are more likely to listen to music while attending to other activities including playing and homework. Comments from the children indicate they enjoy the presence of background music.

Gender studies have linked music to mood. Dial (1996) investigated *The Effects of Background Music on Initial Counseling Sessions.* Female participants in the background music condition had a significantly more positive experience and reported more willingness to return for additional counseling sessions than did their male counterparts. In perhaps a more controversial study, Fisher and Greenburg

(1972) studied 90 female university students. They were given several tests including the *Femininity Scale of California Inventory* (Gough, 1964). The researchers found several positive correlations between the femininity scores and background music. The higher the femininity score the more likely to rate exciting music as pleasant and warm, and calm music as warm and safe. During the no-music condition, high femininity scorers rated tasks as unpleasant, heavy and slow. Low femininity scorers found the background music disturbing. The authors interpreted these results as when background music is forced on an individual not by their own choosing, they are subjected to an input over which they have no control. The less feminine the individual's orientation, the more threatening it will be perceived.

In a study involving the workplace environment of computer programmers, Lesiuk (2005) found that the more time spent listening to music, the greater increase in positive mood. This effect increased steadily over three weeks until the music was removed. Upon removal of the music, there was an immediate decline in mood. The music was reinstated in the fifth week and the mood increased accordingly. It is interesting to note that the older the subject, the less time was spent listening to music. "The general hypothesis proposed in this article is that music listening in some work environments evokes positive affect of mild positive feelings, which in turn increase performance on tasks requiring creative output" (Lesiuk, 2005, p. 185). And, in fact, the quality of work was lowest during the no-music condition and increased after the music was reinstated. It took longer for the programmers to complete work related tasks when the music was absent. The author speculated that work output increased with background music because of a better mood state and pacing.

A line of research has investigated which factors of music and individuals affect mood. Ascending melodies were rated happier than descending melodies (Gerardi & Gerken, 1995). Ascending tones were rated as being happier, brighter, faster, and increasing in tempo more than descending tones (Collier & Hubbard, 2001).

Mood improvement seems to be the result of aesthetic experience (Fisk, 1996); peak experience (Slaboda, 1991); and because music is part of everyday life (DeNora, 2001). Slaboda and O'Neill (2001) reported that everyday use of music resulted in a less positive mood only 13% of the time. Even those choosing to immerse themselves in "sad" music may actually be enjoying themselves; so a positive effect is still the result (Apter, 2001). Finally, Lehmann (1997) found that individuals with greater musical training had greater emotional responses. This supports the hypothesis of the present study.

Tempo

The emotional effect of music tempo and the interaction between gender, personality and music tempo is the subject of several studies. Readers tend to read slower in the presence of slow tempo music. This may be related to the concept of entrainment. However, men evaluate the news more positively while reading in the presence of slow tempo music whereas women judge the news negatively (Kallinen, 2002). The interaction between personality and tempo reveals that those who score high on an aggressive-hostile scale evaluated fast news as more pleasant than slow news. Slow news is judged more pleasant for those scoring low on an aggressive-hostile scale (Kallinen & Ravaja, 2004). This demonstrates that background music affects individuals differently and interacts with other factors within the individual.

Husain, Thompson, and Schellenberg (2002) found that tempo had no effect on mood. However the enjoyment rate increased when music in the major mode was played at a fast tempo or music in the minor mode was played at a slow tempo. Modality will be discussed more fully in the next section.

A quick tempo may improve cognitive performance in some individuals while creating a higher level of distraction with others (Mayfield & Moss, 1989). This corresponds with Brodsky (2001) who found that fast music correlates with more distraction and produces more at-risk driving behavior on simulated driving performance. Fast tempos may also induce greater levels of mental arousal and carry a higher information load to be processed by the listener (Mayfield & Moss, 1989). These results agree with Holbrook (1981) fast music demands more mental resources for processing and is therefore more difficult to perceive than slow tempo music. Other research has found that faster tempos are perceived to be more complex (Milliman, 1982, 1986). These studies will be examined in later sections.

Major and Minor Modes

Modality is another component of background music that seems to influence mood. The major mode is associated with positive mood and positive feelings. The minor mode is associated with a negative shift in mood and melancholy (Husain, et al., 2002; Kellaris & Kent, 1992) also reported that participants performed better on a spatial test when they listened to fast music in the major mode.

Music in the major mode may lead to more productivity and greater satisfaction with communication. However it does not reduce anxiety (Blood & Ferriss, 1993). This corresponds with Biller, Olson, and Breen (1974) who found that “sad” music, defined as slow tempo and minor mode, had a stronger tendency to lessen state anxiety than “happy” music, defined as fast tempo and major mode. This leads us to the discussion of anxiety reduction.

Anxiety Reduction

Anxiety reduction is perhaps one of the most commonly held beliefs when discussing the effects of music on human emotion. Many articles relating to music in anxiety reduction appear in magazines that are not refereed research journals. This demonstrates the interest level by the average consumer for this topic. Research on using music for anxiety reduction has shown mixed results.

Some studies have shown no reduction in anxiety (Ballard, 1980; Blood & Ferriss, 1993; Hardie, 1990; Harper, 2001). Other studies found that the use of background music before and during test taking lowered anxiety and increased performance (Campbell, 1996; Dial, 1996; Haynes, 2004; Kiger, 1989; Kleckley, 1989; Smith & Morris, 1976).

Fisher and Greenburg (1972) studied *Selective Effects upon Women of Exciting and Calm Music.* Results indicate that exciting music produces more anxiety than calm music or silence; and calm music produces less anxiety than silence. The higher the femininity score, the lower the anxiety score during both exciting and calm background music treatments.

Mental Arousal

The final topic under emotional effects is mental arousal (alertness). "McMullen's (1982) theoretical model of the dimensions underlying music meaning suggest that *energy* and *structure* in music are experienced as forms of *activation* or *arousal*" (Radocy & Boyle, 1997, p. 32). Mental arousal is vital for humans to accomplish tasks, especially creative tasks; and to avoid injury, particularly in repetitive factory jobs. However, hyper-arousal can hinder cognitive tasks. The following research supports these statements.

Research about the positive effects of background music on mental arousal dates back to the early 20th century. In a World War II era literature review, Kirkpatrick (1943) reported on the research related to improving factory production with background music. The main hypothesis was that music would increase factory output by decreasing the boredom (increasing arousal) caused by performing repetitive tasks. A summary of the results includes: (a) a daily increase of 6.8% and an over-all increase of 11.4% for every 100 man-hours when music was present, (b) fewer employees went home early and absentees dropped 2.85% with the music present, (c) workers reported that time passed more quickly when their minds did not focus on images outside of work. These results were replicated by Smith (1946).

Yet in the work environment, not all employees like music while they work. Between 1% and 10% are annoyed by background music and the quality of work can be adversely affected (Uhrbrock, 1961).

Husain, et al. (2002) presented a new hypothesis they called "arousal-mood". The basic premise of the arousal-mood hypothesis is that listening to music affects both arousal and mood, which in turn influences performance on certain cognitive skills. If this hypothesis is confirmed, it could explain the so-called "Mozart Effect". Instead of music directly affecting cognitive abilities, music affects arousal and mood. It is arousal and mood that affects cognitive performance. In an effort to confirm their hypothesis, they recorded the same Mozart piece at different tempos and in different modes. Results indicate that fast tempo was associated with increased arousal and slow tempo was associated with decreased arousal.

Different types of music affect mood and arousal differently however (Gabrialsson, 2001). Current research has found that a rising melody corresponds with higher arousal ratings compared to a falling melody (Kallinen & Ravaja, 2004). It may be that a rising melody creates excitement in the listener because it sounds like human speech rising when the speaker becomes excited (Turino, 1999). Rising contours are often linked with attention getting purposes (high arousal) and falling contours with soothing purposes (low arousal) (Fernald, 1992; Papousck, Papousck & Symmes, 1991). Human beings will in one instance talk loudly in order to get attention and then later talk or sing softly to relax a crying baby. Individuals intuitively match the amount of stimulation to the desired level of arousal.

Background music may operate the same way. The correct type of background music provides just enough stimulation to create optimal arousal. For example concentration and speed of completion on math problems increases when calming music is played (Hallam, et al., 2002). However, too much stimulation can lead to a state of hyper-arousal that becomes detrimental to cognitive performance.

High information load (loud, fast, non-repetitive) music that is unfamiliar may actually produce anxiety and tension in the listener, thereby interfering with complex tasks that require concentration (Kiger, 1989). For example, fast music, while improving cognitive performance, corresponds with a higher level of distraction. It induces greater levels of arousal and carries a higher information load to be processed by the listener (Mayfield & Moss, 1989). Fast tempo music in cars may also lead to greater speeds and more traffic violations (Brodsky, 2001).

> The Yerkes-Dodson law states that the arousal level of the individual increases performance up to an optimal level beyond which over-arousal leads to deterioration in performance. The law also states that the deterioration occurs more quickly when the task to be performed is complex or under-learned. A simple task will require a high level of arousal for concentration to be maintained (Hallam, et al., 2002, p. 113).

Following this line of research the ideal music to play for students should reduce arousal and create positive mood (Thompson, et al., 2001). Music perceived as arousing and aggressive impairs performance on a memory task. Lively music can be used to increase arousal and soothing music can be used to decrease arousal after recess and lunch (Hallam, et al., 2002).

As Mehrabian (1976) explains, many musical factors effect information load on the human brain such as loudness, variety, complexity, and tonal range. These factors may produce hyper-arousal. A study by Kiger (1989) suggests that soft, slow and repetitive music (low information load) has the effect of lowering arousal for better performance. In fact these participants performed better than the no-music group. Kiger (1989) proposed that silence might have produced a sub-threshold arousal, which impaired performance. This will be examined in the current study. Information load will be discussed more thoroughly in the next section.

Cognitive Effects

Beyond the physiological and emotional effects, background music has been shown to have an impact on cognition. Cockerton, Moore, and Norman (1997) used a repeated-measures design to examine the effects of background music on an I.Q. test. Results indicated that the participants answered more questions and selected more correct answers listening to background music compared to silence. Because there was no measurable difference in heart rates, the researchers concluded that arousal might not be an explanation for the main effect. There are three broad theories that attempt to explain this phenomenon: (a) cognitive load, (b) simple vs. complex, and (c) stimulative vs. sedative.

Cognitive Load

One possible explanation for the degenerative effects of hyper-arousal mentioned in the previous section is cognitive load. Brünken, Plass, and Leutner (2004) provide a good explanation for two basic concepts needed to understand cognitive load theory. The first concept is modality effect. It is assumed that visual information; auditory information, etc. are processed in different parts of the brain with their own resources. Therefore individuals that receive both visual and auditory information learn better than those who receive only visual information and use only the resources of the visual system.

The second concept is the limited capacity assumption. The idea is that the brain has limited capacity available that has to be distributed among several cognitive processes and their resource requirements. Materials to be learned have a specific intrinsic load depending on their nature. The presentation of the material creates an extrinsic load, which is assumed to make no contribution to the learning process. Cognitive capacity is used to integrate new information into existing schema. This is called germane load. These three loads are added together and use up the resources of the brains total available capacity (Brünken, et al., 2004).

A line of research around the cognitive load theory has been conducted and the results have been fairly consistent. Researchers have presented materials in two or three modalities and then tested the amount of knowledge retained. Learners acquired more information in the audiovisual setting than the visual mode only. There was no significant difference in the visual with background music condition. However when narration was combined with background music there was a significant drop in performance. It was argued that since narration and background music are the same modality, they were both competing for the same mental resources. The brain did not discriminate between relevant and irrelevant information. (Brünken, et al., 2004; Moreno & Mayer, 2000).

These results indicate support for the modality effect and limited capacity assumption in the auditory mode. In light of this research, background music may have no effect on task performance as long as the task is not in the auditory mode. Individuals can perform two complex tasks at the same time as long as they are in different modalities, i.e., visual and auditory (Boal-Palheiros & Hargreaves, 2004; Eysenck & Keane, 1990). Nevertheless, as explained in the previous section musical factors affect humans in differing ways. Arousing music is more cognitively demanding because of the greater number of temporal events to be processed by the brain (Brodsky, 2001). Vocal music and unattended speech is considerably more disruptive than instrumental music or silence. Lyrics increase the information load of background music (Salamé & Baddeley, 1989). Temporal perceptions are even distorted by music. Time seems to pass more quickly. This effect is attributed to limited attentional resources (Kellaris & Kent, 1992).

In a study on the *Effects of Music Information Load on a Reading Comprehension Task* (Kiger, 1989), results indicated that the high information load condition produces interference because of the competing stimuli; whereas the low information load condition may have helped reading comprehension because it diverted less attention and allowed greater concentration. "Educators and employers may want to heed Mehrabian's suggestion to pair low-load music with complex and valued tasks and pair high-load music with simple, routine jobs" (p. 523).

Simple vs. Complex

As previously stated, the background music and the tasks can be simple or complex. It follows that the more complex an activity, the more mental capacity is needed to process and/or complete the activity. Smith (1961) proposed that the cognitive complexity of a task might contribute to the extent that music acts as a distraction. Monotonous tasks would benefit while complex tasks would suffer. Likewise, two more studies (Furnham & Allass, 1999; Furnham & Strbac, 2002) indicate that the background music or noise would only have a negative effect on complex tasks. Also, the results indicated no difference between background music and noise. It was explained that the background music complexity was too close to the complexity of the noise.

In one of the landmark studies on the effect of music distraction on reading (Henderson, et al., 1945) classical, pop and no-music conditions were compared while students took the Nelson-Denny reading comprehension exam. Classical music showed no effect but the pop music group had lower reading comprehension scores. It was suggested that distraction depends on the complexity of the music and complexity of the test materials. Kaniel (1998) suggested that distraction and performance is best thought of as meta-attention (thinking about thinking) and task load. He further suggests that it exists as a negative correlation. The more difficult the task, the more musical distraction should be reduced. At a certain point, the task load becomes so great that any background noise is disruptive.

Musical complexity is determined by a number of factors including: melodic, harmonic, rhythmic, multi-timbral and texture (Arkes, Rottig & Scougal, 1986; Radocy, 1982; Williams, 2005). The number of musical events occurring in a certain period of time relate to the perception of musical complexity. Therefore tempo seems to be an important factor in musical complexity. Faster music is perceived as more complex than slower music (Milliman, 1982, 1986). It may be that fast tempos demand more cognitive resources for processing and is therefore more difficult to perceive (Holbrook, 1981).

Barnes (2002) found no difference in reading comprehension scores in the presence of high or low complexity background music. This may be further justification of the modality effect since they were asked to perform two complex tasks in different modes (Boal-Palheiros & Hargreaves, 2004). Or it may be that the duration of the treatment allowed them to screen out irrelevant stimuli and concentrate on the reading task (Brünken, et al., 2004; Flaum, 1981).

If the theory that musical complexity has a debilitating effect on more complex tasks is accepted, then perhaps the individual's musical training and preference play a role in music distraction. Cheston (1994) found that 11th and 12th grade students with more music training, more musical experience and a high score on the *Advanced Measures of Musical Audiation* (*AMMA*) test, preferred more harmonically complex music. Other research has shown that musical training and musical complexity relate to increased focus of attention to the music (Williams, 2005). In other words, musical complexity and musical training may contribute to background music distraction. This could explain why certain groups of students do not study with music. It could also support the main hypothesis of this research in that those individuals that can hear small tonal and rhythmic changes in music (i.e., high *AMMA* score) are more easily distracted by music, especially as the music becomes more complex.

Stimulative vs. Sedative

While stimulative and sedative seem to be synonymous with complex and simple, there is an important distinction. The terms complex and simple describe the elements that make up a musical composition. Stimulative and sedative refer to the effect that musical compositions have on a human being. According to Radocy and Boyle (1997) the bulk of research in this area was conducted by Gaston's students at the University of Kansas in the 1940s and 50s; and all found significant differences in response to the two types of music. "Gaston (1968, p. 18) has noted that all music exists on a continuum between highly stimulating, invigorating music, and soothing, sedating music" (Boyle, 1982, p. 105). Boyle's own research reveals a commonly held set of verbal descriptions for stimulative and sedative music that are radically different (Boyle, 1982).

Research has shown that sedative music highly correlates with calmness, has a positive effect on math completion, remembering words, and positive social behavior (Hallem, et al., 2002). Playing sedative music before a task has a significant positive effect on task completion compared to those who listen to stimulating music before a task (Borling, 1981; Caspy, Peleg, Schlam & Goldberg, 1988). Chalmers, et al. (1999) studied music as a classroom tool. They played music at a tempo around 60 beats per minute, which would be considered sedative. When classical music was played there was a 6 dB (7%) drop in noise level. When sedative pop music was played there was a 10-12% drop. This effect is summed up in a literature review by Crncec, R., Wilson, S. J., & Prior, M. (2006) stating that the ideal music to play to children in the classroom should reduce arousal and enhance mood.

Frustration leads to a decrease in performance. Sedative music helped alleviate this problem, whereas stimulative music did not. It was suggested that stimulating music tended to maintain the emotions already developed and therefore performance suffered (Caspy, et al., 1988).

The effect on verbal interaction is not clear. A study on the verbal interaction of college students during in-class group work found no effect by either stimulative or sedative music (Bonny, Cistrunk, Makuch, Stevens, & Tally, 1965). However, in a study of the verbalizations of kindergarteners in a Title I school, loud (stimulating) music in particular, was detrimental over time. The no-music control group remained unaffected.

Math Performance

Positive results were found in two studies related to math performance (Hallam & Price, 1998; Hallam, et al., 2002). In the first study the findings suggest that performance and behavior of emotionally disturbed children within the special classroom may be enhanced by the introduction of calming background music. All students performed better on the math tests when background music was present. The greatest effect presented with children whose behavior could be described as hyperactive. In the second study calming music was associated with a faster completion of math problems but it did not increase accuracy.

Many studies found no significant difference in math scores between groups with and without background music (Cavanaugh, 2005; Crncec, et al., 2006; Furnham & Allass, 1999; Gregoire, 1984; Hardie, 1990; Vaughn & Winner, 2000). This may be caused by a fairly equal representation of those who benefit and those who do not within the treatment and control groups; or perhaps another confounding variable interacted with the main effect that is yet to be identified. Fogelson (1973) suggested that if individuals would frequently listen to music while working it would be less distracting and therefore less likely to impair performance. This hypothesis was tested by Etaugh and Ptasnik (1982). They found those who seldom studied with music showed better reading comprehension in silence while those who frequently studied with music performed better in the presence of background music. Reading comprehension will be discussed in the next section.

Other research has indicated negative results. In one study, only two out of seven bright students finished the assigned task with background music present while six out of seven bright students finished without music present (Fogelson, 1973). Furnham and Stanley (2003) found that all of the research groups performed better in silence. Chelder (1985) reported that those given the pretest in silence performed better than those exposed to music during the pretest.

There has been a plethora of research conducted to verify the so-called "Mozart Effect" which claims to increase performance on math and spatial skills exams. For the most part these studies have not been included in this literature review. The difficulty in using those studies is that most of them played music as a catalyst prior to the task rather than as background music during the task, which is the focus of this research. However, Ivanov and Geake (2003) played music on room speakers the entire time including when instructions were given. The results indicated a significant increase in temporal-spatial reasoning between those listening to Bach or Mozart as opposed to those in the no-music condition. It was suggested that the music brought cohesion to the familiar background noise making it less distracting and promoting task performance. These findings are consistent with the arousal effect discussed earlier.

Reading Comprehension

The effect of music on reading comprehension is one of the main concerns of this study. If background music is detrimental to reading comprehension, then using it during study time or classroom reading and test taking time should be discouraged. If, on the other hand, background music increases or has no effect on reading comprehension, then use should be encouraged. Unfortunately, the research has shown mixed results. There seems to be a connection between music perception and reading ability. Anvari, Trainor, Woodside, and Levy (2002) found that musical perception is predictive of reading skill. Correlation studies reveal that students studying music have higher standardized reading scores (Butzlaff, 2000). Douglas and Willatts (1994) found a positive correlation between rhythm score and reading/spelling. They also found a positive correlation between the composite music score and reading. It was not suggested that music training is essential for good literacy skills, but those identified with reading problems might benefit from a structured music program. Although correlation studies do not prove causality, they can provide direction for experimental research. A follow-up pilot study found a small increase in the treatment group as opposed to those with no music intervention.

Hall (1952) found that music played in study hall increased reading comprehension in adolescent students. Chalmers, et al. (1999) discussed the "Lozanov" method of "Suggestology". This method combines background music with softly spoken information to accelerate learning (Ostrander & Schroeder, 1979). Yellin (1982) used an Americanized version called Suggestive-Accelerative Learning and Teaching (SALT) and reported gains in both silent and oral reading.

A landmark study (Mitchell, 1949) examined the effect of a radio variety show versus radio broadcast music on the reading comprehension of sixth grade students. The results indicate the group was negatively affected by the variety show but unaffected by the music. Those with I.Q. scores around 100 made a significant gain in reading comprehension during the music broadcast. Those with I.Q. scores below 100 were either slightly improved or not affected in their reading comprehension scores.

Several studies found no effect of background music on reading comprehension (Kiger, 1989; Martin, Wogelter, & Forlano, 1988). Martin, et al. (1988) found unattended speech to be much more distracting than music. They concluded that meaningful information (speech) is more likely to impair cognitive performance.

Many studies have documented negative effects of music on reading. Fogelson (1973) divided 8th grade students into four groups: bright/no-music; bright/pop music; non-bright/no-music; non-bright/pop music. Results indicated that playing pop instrumental music during test taking was detrimental to their reading performance. Also bright students found the music relaxing, whereas non-bright students found the music distracting. It is possible that these results merely support the conclusions given in previous sections (i.e., Yerkes-Dodson law, cognitive load theory and cognitive complexity). Perhaps the task was more complex for the non-bright students and therefore the music was more distracting for them. Either way there was also an effect on the bright students. Therefore there may be another variable involved in their distraction.

Other studies have demonstrated that reading performance declined in the presence of both music and noise (Furnham & Strbac, 2002). Introverts were more negatively affected than extroverts. Introversion will be discussed extensively in the last section. Reading rate and efficiency decreased when background music tempo was slowed down (Kallinen, 2002). Interestingly, 63% of the participants in the Kallinen (2002) study reported that the background music was not disturbing. It may be that many people do not realize they are being distracted. Distraction verses focus of attention will be discussed more thoroughly in the next section.

Personality Effects

Focus of Attention

The author conducted an informal survey of library patrons studying with music in headphones or ear buds. When asked why they study with music playing, the general responses were because it blocks everything out so that they could concentrate. Some even said that they could not study without music playing. Yet other patrons sitting in the same area stated that they came to the library in order to get away from music and background noise so that they could concentrate. These opposite responses are also reflected in the literature. Soothing music was shown to improve concentration (Savan, 1999). Keyboard operator's (typist) work rates were unaffected by the presence of background music (Gladstones, 1969). Yet 8th graders in a no-music condition scored significantly higher on quizzes and final grades than students who listened to classical music continuously during class time (Johnson, 2000). It was suggested (Hallam, et al., 2002) that background music benefited some students because, if concentration were lost, their attention becomes focused on the music rather than disruptive behavior that disrupts others. The student listens briefly then returns to the task.

Focus of attention may be an acquired skill or a personality trait. A study on focus of attention (Darrow, Johnson, Agnew, Rink Fuller, & Uchisaka, 2006) asked music and non-music majors to take the *D2 Test of Attention*. Participants listened to their preferred music for half of the test and silence for the other half. All of the participants performed better on the test while the background music was playing. This supports the hypothesis that background music helps with focus of attention. However, music majors scored significantly higher. It was suggested that the process of practicing prepared those with musical training to be more adept at a detail oriented test like the D2. This supports the hypothesis that focus of attention may be acquired through training.

This research coincides with the results of two studies asking students and faculty to self-report distractions while listening to music (Flowers, 2001, 2005). In the first study, music faculty were the least distracted and non-music faculty were the most distracted with scores from 6th graders in-between. These results support the hypothesis that training can affect concentration. In the second study, children were more distracted listening to music composed by Bach than listening to prose. It was suggested that the story required that the children pay attention in order to understand the plot, whereas the music sparked their imagination, which led to distraction from the music itself.

The interaction between music type and the learning traits of field independence or dependence was studied by Green (1984). A field independent person can easily distinguish component parts from the background. Field dependent individuals see the total field so that the parts are not easily perceived. Green (1984) found that field dependent students should benefit from slow baroque music and field independent students should benefit from pop music.

Introversion vs. Extroversion

de Groot (2006) studied the effect of background music on learning and forgetting foreign language vocabulary words. The findings indicate that only a subset of the students benefited from the music treatment. The researcher did not wish to speculate on why this group benefited where others did not, but referred to the current research on the personality trait of extroversion. These results are actually common. Almost all of the research discussed in this chapter explores the physical, emotional, and cognitive effects of background music on human beings. And in most cases there are individuals unaffected by the background music treatment. This final section of the literature review examines research that attempts to answer why. What is different about individual humans that make them more or less affected by background music? The answer to that question might be found in the personality traits of introversion and extroversion.

A series of studies on distraction and the cognitive performance of introverts and extroverts were undertaken by Furnham and Allass (1999), Furnham and Bradley (1997), Furnham and Stanley (2003), Furnham and Strbac (2002), and Furnham, Gunter, and Peterson (1994). This research was based on the foundational work of Eysenck (1967, 1981) and Eysenck and Eysenck (1975). In his book *The Biological Basis of Personality*, Eysenck (1967) argued that introverts and extroverts operate at different levels of mental arousal. Introverts require less external stimulation to operate at optimum mental functioning level. Extroverts require a much greater amount and actively seek stimulating environments.

This theory was upheld by Morgenstern, Hodgson, and Law (1974) who found that extroverts actually performed better in the presence of distractions than silence, and by Campbell and Hawley (1982) who analyzed the study habits of introverts and extroverts. They found that introverts would find an isolated space in the library away from the traffic and noise, whereas extroverts would seek out the noisier places.

If Eysenck's (1967) theory is true, then extroverts require external stimulus to remain mentally alert. Silence could possibly lead to drowsiness or daydreaming. On the other hand, it takes so little external stimulus for introverts to reach optimal mental arousal that the further it is exceeded, the higher the likelihood for hyper-arousal to occur and hinder performance. This makes it more difficult to find background music that would help extroverts without hindering introverts. That is the basis for the works of Furnham and Allass (1999), Furnham and Bradley (1997), Furnham and Stanley (2003), and Furnham and Strbac (2002).

In the first study, Furnham, et al. (1994) studied the distraction of introverts and extroverts taking two reading comprehension tests one in silence and the other in the presence of television. Both groups scored higher in silence, but the performance of the introverts was more negatively affected in the presence of television than the extroverts. Also during post-test questioning, introverts reported being more distracted in the presence of television than extroverts. This study was replicated (Furnham & Bradley, 1997) using a pop music commercial radio station instead of television. Similar results were found. Introverts performed significantly less well in the presence of background music than extroverts. Extroverts indicated that they were more likely to study with the radio on.

In a similar study, Daoussis and McKelvie (1986) allowed participants to choose their own background music while taking a reading comprehension test. There was no difference in the performance of extroverts between music and silence. However introverts were significantly impaired by low volume background music. Furnham and Bradley (1997) suggested that introverts would adapt to the background music over a reasonably long period of time. The background music played was from a commercial radio broadcast and uncontrolled for style, tempo, complexity or mode (discussed earlier in this chapter).

In a later study, Furnham & Allass (1999) examined the distraction of simple and complex music or silence on the performance of introverts and extroverts. This research was based on a theory proposed by Berlyne (1971, 1974). The theory states that the most preferred music is that which occurs at a moderate complexity. It is the point at which the majority of individuals would be neither under or over aroused. It is sometimes represented as an inverted U. Music was selected from each of the extremes and played through headphones. The results indicated the extroverts performed better than introverts in a short-term memory task and performed the best during the most complex music condition. Introverts outperformed extroverts in every task during silence.

The results of Furnham & Allass (1999) are in agreement with earlier studies and lend support to the theory that extroverts would benefit from background music while introverts would be hindered. In the follow up questionnaire introverts reported that the complex music was significantly more distracting than the simple music. Extroverts reported no difference between simple and complex. This would seem to indicate that simple music would provide the optimum balance for both introverts and extroverts. However, the data from the cognitive tests during the simple music condition followed no pattern. “One explanation for this phenomenon may be that the variable of music has interacted with some other unspecified variable, such as musical preference or previous exposure” (Furnham & Allass, 1999, p. 36). The purpose of the current research is to explore the hypothesis that tonal and rhythmic perception is that unspecified variable.

The study that most closely relates to the current investigation is Furnham and Strbac (2002). Their study is an extension of previous research by including background noise as an alternative distracter to background music on the performance of introverts and extroverts taking three cognitive tests. After completing the *Eysenck Personality Questionaire* (Eysenck & Eysenck, 1975), seventy-six students were classified as either extroverted (38) or introverted (38). All of the participants spoke English as their primary language. In groups of 8 to 21 the participants were asked to complete the pretest questionnaire and the *Eysenck Personality Questionnaire*. Afterwards they completed a reading comprehension test, a prose recall task, and a mental arithmetic task; one test in silence, one test with noise, and one test with background music. The sound was played on a cassette player at the front of the room. A Latin Square was used to counterbalance the design.

Afterwards the participants were given a post-test questionnaire that asked them to rate on a seven-point Likert scale how distracting they found the noise and background music and how motivated they felt. They were also asked how frequently they studied or worked with background music or noise. The experiment took approximately 40 minutes.

Results indicated a decline in performance by all participants in the presence of noise or background music. There was no difference in scores between introverts and extroverts in the silence condition. Extroverts outperformed introverts on all tests during the noise or music conditions. However, there was only a significant difference on the reading comprehension test. Also the music and noise conditions were not significantly different from each other. The reason, it was suggested, was that the complexity of the music was close to the complexity of the noise. This research provides additional evidence that the performance of introverts is hindered by the presence of background music and noise particularly when asked to participate in a complex task such as reading comprehension. The lack of significant difference in the scores of the other two tests opens up areas for further research.

Furnham and Strbac (2002) suggested that the tasks were not complex enough to cause introverts to exceed their optimum functional level or that there needed to be more participants to increase statistical power and then only analyze the data from the extreme groups. This last argument is based in part on the assumption that high scoring introverts performed at the same level as lower scoring extroverts. Perhaps there is another explanation.

It may be that introversion and extroversion are only one of the human variables influencing background music distraction. Perhaps musical perception in combination with personality traits would explain the results. Many people only hear music at a surface level. This could explain the high functioning introverts. Other people hear the subtle changes in tonality and rhythm. This could explain the low functioning extroverts. To further substantiate this hypothesis, Furnham and Strbac (2002) did not find a correlation between the self-reported distraction of music/noise and their actual scores or the amount of time spent studying with background music/noise. Therefore personality traits might not provide a complete picture.

In their latest published study, Furnham and Stanley (2003) focused on the differing effects of vocal and instrumental music on introverts and extroverts. They also analyzed the study habits of introverts and extroverts. The results indicated that all students performed better in silence. This conforms to previous research. Unlike previous research however, extroverts did not benefit from the background music condition. It was suggested that the tasks were too easy causing a "ceiling effect". Extroverts did perform significantly better than introverts on the phonological task.

Vocal music was more detrimental to performance than instrumental music. This corresponds with earlier studies. For example, Furnham and Allass (1999) stated that the most distracting music is fast, vocal music that is well known and liked by the listener.

The results of the study habits survey found that 55.5% of introverts prefer to study away from distraction verses 30.9% of extroverts. Sixty-nine (69%) percent of extroverts prefer to study with background music, whereas only 53.3% of introverts study with background music. These numbers may already be higher today with the almost ubiquitous use of the ipod and other mp3 devices. Also introverts indicated they significantly prefer to work independently and feel they are more productive in that environment. They do not like working in groups and indicated that they cannot concentrate with others present.

Barnes (2002) attempted to replicate and expand this body of research by studying the effects of silence, simple instrumental music and complex instrumental music on the reading comprehension scores of 90 introverted, ambiverted and extroverted undergraduate students. Neither extroverted nor introverted students were affected by either music condition. These results further suggest that the personality traits of introversion and extroversion are not the sole factor influencing background music distractibility.

Summary of Research Findings

Over the past sixty-five years there has been a great deal of interest and research on the effects of background music on human beings. Studies have indicated that background music affects several physiological parameters including: blood pressure, body temperature, heart rate, and the stimulation of certain brain chemicals. This research fits with the exploration of music on behavior. Many studies have suggested that slow calming music reduces inappropriate or undesirable behavior. Educational studies both in the special and regular classroom have identified slow soft music as decreasing out-of-seat and talk-out behaviors while increasing on-task and less disruptive behavior. Loud, fast, popular music has been shown to increase inappropriate behavior. These results have been replicated in nursing homes and clinics on individuals with mental and/or emotional disorders.

Several emotional effects of background music have been documented. Although most people enjoy the presence of music, some find it very distracting and become annoyed. This may be related to personality factors. The presence of background music seems to affect the attitude towards the activity being performed and might lead to greater productivity in certain office related occupations. Fast music in the major mode is associated with a positive mood, while slow music in the minor mode is associated with a more melancholy mood. Background music has proven beneficial for noise masking and distraction during unpleasant tasks, such as running on a treadmill. However it was shown to be detrimental to cognitively impaired seniors attempting to complete basic functional tasks. The use of music to reduce anxiety has shown mixed results. Other factors may be involved. The use of music to increase or decrease mental arousal has shown more consistent results. Playing exciting background music seems to stimulate mental arousal and benefit humans performing repetitive tasks such as factory workers. Too much stimulation can result in hyper-arousal, which distracts drivers and disrupts reading comprehension. These effects seem to affect individuals differently. Lehman (1997) points out that individuals with greater musical training seem to have a greater emotional response.

Cognitive load theory may explain why certain types of music are beneficial or distracting. Each modality channel (auditory, visual, etc.) has its own set of mental resources. Therefore it is detrimental to performance if two visual tasks or two auditory tasks are happening simultaneously. Also, musical complexity seems to have a cognitive load. The more complex (fast tempo, complicated rhythms, overlapping voices, etc.) music becomes, the greater amount of mental resources are required to process the music. This can interfere with performance if the task is also complex. Stimulating music tends to be more complex and has been shown to interfere with the completion of math assignments, whereas sedative music has been shown to aid in the completion of math assignments as well as increase desired classroom behavior.

In the classroom, some studies have found that background music increased the speed students finished a math test but did not affect accuracy. Several studies have found no difference between music and silence. Others have found that fewer students finished the math task in the presence of music compared to silence. One study found that only a small subset of students benefited from the background music. Reading ability seems to share the same mental processes as music. A few studies have shown a beneficial effect of background music on reading. However, many studies reported background music detrimental to reading comprehension. In addition, certain students are more negatively impacted than others.

Background music may improve focus of attention. While this may be related to noise masking, several studies have found that music training interacted positively with the main effect. It may be that music training increases focus of attention and is unrelated to the background music. Also, it implies that focus of attention may be acquired through practice.

Finally, individuals may be affected by background music to a greater or lesser degree depending on the personality traits of introversion and extroversion. According to this theory, background music would stimulate the brains of extroverts increasing their cognitive arousal state to the point of optimal efficiency, while the same background music would cause hyper-arousal in introverts hindering their cognitive functions. This would explain why stimulating music hinders certain people and helps others. The body of research confirms this theory for the most part. Introverts were less negatively affected by sedative (low arousal) music than stimulative (high arousal) music, and extroverts tended to be either unaffected or benefited by both types of background music. However, there was a group of extroverts that were not benefited by the background music and a group of introverts that were not as negatively impacted as the other introverts.

It is reasonable to assume that the many components of music such as tempo, modality, texture, style, dynamics, etc. interact and affect individuals differently based on their experience, culture and training. Many of the studies reviewed in this chapter have attempted to examine each of these components to determine what effect they have on individual humans. The results have been reported and shown to only work in generalities. Many who should benefit from background music do not and some are even negatively impacted. The personality traits of introversion and extroversion seem to most consistently predict the effects of background music on the individual. Yet even this variable does not account for the subsets that do not follow the predicted outcomes. Therefore the large number of studies showing conflicting or mixed results may indicate the presence of another variable interacting with the main effect and causing inconsistent results.

Purpose

Another possibility for the differences in the way individuals are affected by background music may be in the way they hear music. Some individuals hear the component parts of music, while others listen only at the surface level. Green (1984) referred to those who distinguish component parts from the background as field independent. It might be the case that individuals who are able to distinguish subtle changes in music are more likely to be distracted by background music no matter their personality traits.

The purpose of this study was to examine the relationship between the ability to hear subtle rhythmic and tonal variations in music and the amount of background music distraction on three cognitive tasks (*D2 Test of Attention*, *Nelson-Denny Reading* Comprehension/Reading Rate, Spatial Ability Test). The following research questions were addressed:

1) After controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does the background music condition predict the scores on tests of reading comprehension, reading rate, attention, and spatial ability?

1a. After controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the scores on the reading comprehension section of the *Nelson-Denny Reading Test*?

1b. After controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the reading rate scores on the *Nelson-Denny Reading Test*?

1c. After controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the scores on the *D2 Test of Attention*?

1d. After controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the scores on a test of spatial ability?

2) To what extent do composite *AMMA* scores and scores on measures of reading comprehension, reading rate, attention and spatial ability predict the percentage of time spent listening to music while studying?

CHAPTER THREE

METHOD

In order to accomplish this task, music aptitude scores were paired with stimulative and sedative background music or with no background music to test their effect on four cognitive tasks. Participants were also asked to report the percentage of time they study with background music present.

Pilot Study

On May 6, 2008 a pilot study was conducted to test the research procedures and data – gathering instruments. All research procedures and data – gathering instruments were included in the same order and time limits as proposed for the main study.

Participants consisted of 30 undergraduate students, fifteen male and fifteen female. One male subject was eliminated from the study after acknowledging that English was not his primary language, leaving a total *N*=29. Testing occurred in two sessions in the same week. During the first session, all 29 participants were given the pretest questionnaire, informed consent form, and the *Advanced Measures of Music Audiation (AMMA)*. Three follow-up meetings were established and the students volunteered for the day and time they could come for the second session. This resulted in the following group make-up: Group A (*n*=11), Group B (*n*=7), and Group C (*n*=11). The test order and music condition was given to each group as explained in the Procedures section of this chapter.

The *Advanced Measures of Music Audiation*, *Nelson-Denny Reading Test*, and *D2 Test of Attention* are commercial standardized tests. They were each used in accordance with the provided instructions. The researcher created the spatial skills test (Appendix E) from online examples. After the collection of the pilot data, a split-half reliability test (Cochran's Test) was conducted on the spatial test answers (r = .78). Cochran's Test gives the same result as the K-R 20 with dichotomous variables. The split-half score is affected by the sample size. Therefore the reliability score was expected to be higher in the main study.

Revisions Suggested

After the data were collected and analyzed, it was found that the three *AMMA* scores (tonal, rhythm, composite) are significantly correlated ($p < .001$; see Table 1)

This creates a special problem in statistics called multicollinearity. It occurs when two or more of the independent variables are highly correlated. The solution to the regression weights becomes unstable. Therefore it was decided that only the composite score would be used in the regression analysis.

The analysis of the pilot data, made clear that the research questions needed to be rewritten and expanded in order to provide more clarity. This task was finished and the revised research questions are those presented at the end of chapter two.

On the Post-Test Questionnaire, only two questions were useful in answering the research questions. It was decided that these two questions be retained and the others eliminated.

Table 1

Intercorrelations Between Subscales for Advanced Measures of Music Audiation (AMMA)

	Tonal	Rhythm	Composite
	Students ($N = 29$)		
AMMA Tonal Scores	_	.566*	.860*
AMMA Rhythm Scores		_	.903*
AMMA Composite Scores			_

*Correlation is significant at the 0.001 level (2-tailed).

It was decided that the time to complete the *Spatial Ability Test* be reduced from ten minutes to eight minutes in order to prevent a ceiling effect. A space to write group assignment was added to the *Spatial Ability Test* answer form and the Post-Test Questionnaire.

Several changes were made during the pilot study data analysis. Descriptive statistics, stem and leaf plots, means and standard deviations were conducted for each variable. The standard score for the Nelson-Denny was used instead of the percentile score because it fit the normal distribution. For each of the research questions a Pearson product-moment correlation and a scatter plot were conducted to check simple correlations and identify outliers.

In research question one, four multiple regressions were conducted with the scores of each of the three tests as the dependent variable, background music condition and *AMMA* composite scores as the predictor variables, and controlling for gender, familiarity and ACT composite scores. The adjusted R^2 was low in all cases because of the small *n* in each group.

To address research question two, multiple regression analysis was conducted with percentage of time spent listening to music while studying as the dependent variable and composite *AMMA*, reading comprehension, reading rate, attention, and spatial ability scores as predictor variables.

Overall, the research procedures went smoothly and the data instruments were not difficult to use. The students understood and followed all of the verbal instructions as presented. This pilot proved to be a good practice run for the main study that follows.

Participants

Eighty-four general college students (N= 84) enrolled in a midwestern four-year college were given the *Advanced Measures of Music Audiation* (*AMMA*). Gender, age and composite ACT scores were asked on a pretest in order to control for possible interactions with the main effect. The students were asked if English is their primary language to prevent adding a confounding variable to the reading comprehension and reading rate tests. All eighty-four of the students indicated that English is their primary language.

The composite *AMMA* scores were placed in order from highest to lowest. The students were then divided into three equal groups (n = 28). A one-way ANOVA was performed to check that there was no significant difference of *AMMA* composite scores between groups, F (2,1) = .236, p >.70.

Design

This study used a counterbalanced design in which participants experienced each of the three background music conditions (no music/sedative/stimulative) and completed a different cognitive test during each music condition. The order of the tasks and the order of the music conditions were counterbalanced to avoid any order effect.

In addition to the *Advanced Measures of Music Audiation*, all participants completed four cognitive tasks (*D2 Test of Attention*/*Nelson-Denny Reading Test*: Part II – comprehension/*Nelson-Denny Reading Test:* Part II – reading rate/spatial ability test). Multiple regression was used to analyze the *D2 Test of Attention*, *Nelson-Denny Reading Test* and spatial ability test scores separately, controlling for gender, composite ACT scores, familiarity with the background music examples, and using composite *AMMA* scores and background music condition as predictor variables.

Materials

Music

Two selections from *The Planets, Op. 32* by Gustav Holst and two selections from *Symphony No. 3, Op, 78 "Organ"* by Camille Saint- Saëns were chosen to be used during the treatment conditions of the current study. "Venus, the Bringer of Peace," 2nd movement from *The Planets* and "Poco Adagio," 2nd movement from *Symphony No. 3* were used during the sedative background music treatment. "Jupiter, the Bringer of Jollity," 4th movement from *The Planets* and "Allegro Moderato," 3rd movement from *Symphony No. 3* were used during the stimulative background music treatment.

These pieces were chosen based on patterns found in previous studies. Caspy, et al. (1988) and Rohner (1980) used the “Largo” from *Dvorak’s New World Symphony No. 9 in E minor, Op. 95* for the sedative music, and the first movement of Beethoven’s *Symphony No. 7 in A minor, Op. 92* for the stimulative music. Holst’s “Venus” and Saint- Saëns’ “Poco Adagio” share many of the same sedative characteristics with Dvorak’s “Largo” from the *New World* such as: slow tempo, soft dynamic range, gradual crescendos, legato, thinly scored instrumentation, and emphasis on strings and woodwinds. Characteristics of stimulative music are shared by Holst’s “Jupiter”, Saint- Saëns “Allegro Moderato” and the first movement of Beethoven’s *Symphony No. 7*: fast tempo, a generally broad dynamic range, disjunct melodic lines, quick crescendos, thickly scored instrumentation and a feeling of energy and forward motion. All of these pieces include tonal and rhythmic variation, which is an integral part of this study.

These characteristics are consistent with those defined by Boyle (1982).

> Music which stimulates or arouses listeners has a strong energizing component. Such music is characterized by detached, percussive sounds; also it usually has definitive and repetitive rhythms. Music which tends to soothe, calm, or tranquilize, however, appears to rely on sounds which are nonpercussive and legato. Tempos for music which tends to sedate activity are

> slower than for music which stimulates activity, and the underlying beat of music which sedates often is monotonously regular and subdued. (p. 105)

Other studies have used music from such popular genres as pop, rock, jazz, blues and funk (Brodsky, 2002; Fogelson, 1973; Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Stanley, 2003; Furnham & Strbac, 2002). Several studies have used a combination of "classical" and "pop" genres (Ausbrooks, 1994; Ballard, 1980; Chalmers, et al., 1999; Freeburne & Fleischer, 1952). The difficulties in using popular music is finding examples that meet both the requirements for sedative or stimulative music and do not have lyrics. Darrow, et al. (2006) have suggested that lyrics are a greater distraction than the music. It was decided to use traditional orchestral music.

A separate compact disk was burned for each of the treatment conditions. During the treatment conditions the music was played from a compact disk connected to a classroom stereo system at a moderate loudness level. A decibel meter was used prior to the treatment in order to mark the volume control knob on the stereo unit for both the sedative and stimulative music examples. Decibel levels ranged throughout each of the pieces from 55 dB to 70 dB.

Tests

All participants completed three cognitive tests; the *Nelson-Denny Reading Test*, the *D2 Test of Attention*, and a spatial ability test. The *Nelson-Denny Reading Test* provided both a reading comprehension score and a reading rate score. These tests placed demands on several different cognitive functions, such as reading comprehension, language skills, concentration, spatial orientation and problem solving. The tests were given in one of the following conditions. One test was given while stimulating background music was played. One test was given while sedative background music was played. One test was given with no background music present.

The following information is from the test manual for the *Advanced Measures of Audiation* (Gordon, 1989). The *AMMA* is a timed test that requires twenty minutes to complete. In order to ensure reliability, a CD is played that includes both the instructions on how to take the test and all of the test questions. According to the test manual the *AMMA* may be administered to either a group or an individual.

Each test question consists of a short musical statement followed by a short musical answer. The test question number is announced and then the first statement is played. After the second statement is played the subject is asked to choose between three possible answers: tonal, rhythm or same. If there was a tonal change, the subject marks *tonal* next to the question number. If there was a rhythmic change, the subject marks *rhythm* next to the question number. If there was no change, the subject marks *same* next to the question number. There is only one answer possible. There will never be both a tonal and rhythmic change. The matched musical statements and answers have exactly the same number of notes to prevent participants from simply counting the notes. Also the tonal or rhythmic change can happen at the beginning, middle or end of the musical answer.

The tonal changes may affect tonality and/or keyality. The rhythmic changes may affect duration, meter, and/or tempo. The music examples were composed for the test and entered into a computer. The computer played the music examples through an electronic keyboard in order to prevent undesirable multiple changes caused by human error.

The *AMMA* requires no prior knowledge of music, only tonal and rhythmic perception. The test provides three raw scores: tonal, rhythm and composite. The raw scores are then compared to the provided standardized norms in order to calculate a percentile score in each area.

The *d2 Test of Attention* (Brickenkamp & Zillner, 1998) was selected to test concentration and distractibility. It is a widely used neuropsychological tool in Europe and has recently been tested for internal consistency and validity using a U.S. sample (Bates & Lemay, 2004). The results indicated that it is indeed a valid measure of attention in the United States. “The internal consistency coefficients were nearly identical to those previously reported in other countries…”(p. 398).

The d2 Test is a cancellation test of attention and concentration. It consists of 14 rows (known as trials) each containing 47 “d” and “p” characters. Between one and four dashes are located above and/or below each “d” and “p”. The object is to mark through only the “d’s” that have two dashes either above, below or one above and one below. This is why the test is called d2. The test taker must move from left to right and complete each trial within twenty seconds. There are no breaks between trials therefore the entire test takes two minutes forty seconds.

The reading comprehension test and reading rate test was taken from part II of the *Nelson Denny Reading Test*, Form H. This is a standardized test used to determine reading rate and reading comprehension. Participants were instructed to begin reading the first test example at their normal reading speed. After one minute, the researcher announced "mark" and the students were instructed to mark which line they were reading at the time. This was used to calculate reading rate. The students then continued reading and answering the comprehension questions in the time remaining. They were given only ten minutes to complete the test.

The spatial intelligence test (Appendix E) was adapted from the *Spatial Ability Practice Test 1* found at http://www.psychometric-success.com/downloads/download-spatial-ability-practice-tests.htm. The first part of this exam consists of a series of shapes, which have to be matched. The shapes may have to be rotated mentally in order match them. The second part of the exam provides a city map, gives a series of directions, then asks what intersection or building the imaginary pedestrian is standing near. The test taker was allowed eight minutes to complete as many answers as possible. They were awarded one point for each correct answer for a total of 33 points.

A pretest questionnaire was constructed (appendix C) including: personal contact information, age, gender and a consent form to grant permission to be included in the study.

A post-test questionnaire was constructed (appendix D) asking the participants to rate how often they study with background music and to indicate if they recognized any of the music played during the treatment phase.

Procedure

Participants were given the pretest questionnaire (appendix C) asking personal contact information, gender, a permission form to access ACT scores and a permission form to agree to participate in the study. It was explained that the information is confidential and that the results would not impact their class grade in any way. Those who desired to see their results may contact the researcher at any time. After the pretest questionnaire was completed, participants were administered the *Advanced Measures of Music Audiation* test, which took twenty minutes to complete. This concluded the testing for that day.

The composite *AMMA* scores were placed in order from highest to lowest. The students were then divided into three equal groups (n = 28). A one-way ANOVA was performed to check that there was no significant difference of *AMMA* composite scores between groups (F (2,1) = .236, p >.70).

A different pair order was used with each class. The order in which the task-background music mode pairs were presented was counterbalanced to control for order effect. This process allowed every participant to experience each of the three music conditions.

The tasks and background music conditions were paired as follows:

Pair 1	Pair 2	Pair 3
D2/No Music	Nelson Denny/Sedative	Spatial Task/Stimulative
Nelson Denny/Stimulative	Spatial Task/No Music	D2/Sedative Music
Spatial Task/Sedative	D2/Stimulative Music	Nelson Denny/No Music

After the treatment groups were established, the experimental procedure commenced. In all conditions the background music was played from a CD player connected to a classroom stereo system at a decibel range from 55 dB to 70 dB. The decibel range is based on other studies in background music (Obrecht, 1990; Staum & Brotons, 2000; Wolfe, 1983).

The first task was handed out. Before the participants began, they received instructions on how to properly complete the task and how much time was allowed (See task analysis in appendix F). Sedative, stimulative, or no background music was turned on when they began the task depending on the pair order for that group.

After the time expired the second task was handed out and the first task was collected. Instructions and background music treatment followed the same process as the first task. Upon completion of the allotted time the third task was handed out and the second task was collected. Once again the same procedure was followed as with the first two tasks.

When the third task was finished and collected, a post-test questionnaire (appendix D) was given. The questionnaire asked participants to identify how often they study with background music. They were also asked whether they recognized the pieces used during the treatment to see whether familiarity with the background music contributed to the main effect. Total time for the second day was approximately forty minutes. All tests were hand scored by the researcher. An alpha level of .05 was used for all statistical tests.

CHAPTER FOUR

RESULTS

The purpose of this study was to investigate relationships among the ability to audiate musical stimuli (as measured by the *Advanced Measures of Music Auditation* [*AMMA*]), different background music conditions, familiarity, gender, general academic achievement (as measured by the ACT), age, and self-reported frequency of background music use on the level of distraction caused by background music. Eighty-four college students participated (N = 84), divided into three equal groups (n = 28) according to their performance on the *AMMA*. Descriptive statistics for each variable are found in Table 2. Table 3 displays correlation coefficients (Pearson) among all variables.

Table 2

Table of mean scores and standard deviations for ACT, AMMA, spatial ability, reading comprehension, reading rate, d2 test of attention, self-reported frequency, age and familiarity by group.

	Groups			
	A	B	C	Total
ACT Composite				
Mean	21.11	19.23	19.76	20.06
SD	4.52	3.56	3.87	4.50
AMMA Composite				
Mean	50.89	47.82	47.18	48.63
SD	20.80	22.18	21.84	21.41

Table 2 (continued)

	Groups			
	A	B	C	Total
Spatial Ability				
Mean	26.96	25.86	24.29	25.70
SD	3.93	2.88	5.35	4.27
Reading Comprehension				
Mean	173.25	164.64	163.21	167.40
SD	10.65	14.17	13.60	13.50
Reading Rate				
Mean	208.61	198.39	196.79	201.26
SD	23.90	21.31	21.29	22.56
D2 Test of Attention				
Mean	221.11	187.50	177.46	195.36
SD	42.99	28.42	36.12	40.51
Self-reported frequency of music use while studying				
Mean	52.50	38.57	51.79	47.62
SD	29.14	28.51	35.49	31.50
Age				
Mean	19.32	18.71	19.25	19.10
SD	3.60	1.18	2.05	2.47
Familiarity with background music				
Mean	.61	.68	.86	.71
SD	.50	.48	.36	.45

The ACT composite scores correlated significantly with scores of all four cognitive tests ($p < .01$). Furthermore, the *D2 Test of Attention* concentration performance scores correlated significantly with spatial ability, reading rate and reading comprehension ($p < .01$). Reading comprehension correlated with reading rate. Also, Familiarity with the background music correlated with gender and D2 concentration performance scores. All other coefficients were not statistically significant.

Table 3

Intercorrelations Between Test Variables

Scores	1	2	3	4	5	6	7	8	9	10
					Students ($N = 84$)					
1. ACT Composite	–	.11	.51*	.49*	.35*	.47*	-.02	-.104	-.09	-.03
2. *AMMA* Composite		–	.15	-.02	.17	.03	-.00	-.06	.04	.00
3. Spatial Ability			–	.19	.10	.48*	-.00	-.03	.04	-.09
4. N-D Reading Comprehension				–	.40*	.38*	-.07	-.05	.00	-.16
5. N-D Reading Rate					–	.28*	.13	-.13	-.13	-.03
6. Concentration Performance Score from the D2						–	-.02	-.15	.03	-.23*
7. Self Reported Frequency							–	-.15	.06	-.02
8. Age								–	.19	.18
9. Gender									–	-.24*
10. Familiarity with music										–

*$p < .05$

Addressing all of the research questions required a total of 33 statistical tests. (Only the final steps of the hierarchical analysis were considered to be part of the study.) In order to maintain the study alpha level of .05, a correction to $p \leq .002$ (Bonferroni) was required for any one test of statistical significance.

In order to answer Research Question One, four multiple regression analyses were performed, with spatial ability, the two tests of reading (comprehension, rate) and the D2 concentration performance score as the dependent variable for each of the analyses. The multiple regression analyses were set up hierarchically. The variables of background music, gender, and ACT were entered in the first step. *AMMA* composite scores added entered in the second step, and two background music conditions were added in the third step. This process was repeated in each of the four regression analyses.

Because background music contained three different categorical conditions, the development of two dummy variables was required. The first dummy variable (in the tables, “sedative condition”) compared the sedative music condition with the no music condition. The second (in the tables, “stimulative condition”) compared the stimulative music condition with the no music condition.

Research Question 1a. Nelson-Denny Reading Comprehension as Dependent Variable

Research Question 1a asked, after controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores to what extent does background music condition predict the scores on the reading comprehension section of the *Nelson-Denny Reading Test*?

The overall model significantly predicted reading comprehension scores on the *Nelson-Denny Reading Test*, $F(6, 77) = 5.86$, $p < .001$. Table 4 reports outcomes by individual variable (see Step 3 of the hierarchical analysis). Of the six independent variables, only the ACT composite score significantly predicted scores on the *Nelson-Denny Reading Test*.

Table 4

Summary of Hierarchical Regression Analysis for Variables Predicting Nelson-Denny Reading Comprehension Scores (N = 84)

	Variable	*B*	*SE B*	β	*t*	*p*
Step 1						
	Gender	.20	2.80	.01	.07	= .94
	Familiarity	-4.25	2.96	-.14	-1.44	= .16
	ACT Composite Score	1.65	.33	.48*	4.96	< .001
Step 2						
	Gender	.30	2.81	.01	.11	= .91
	Familiarity	-4.22	2.97	-.14	-1.42	= .16
	ACT Composite Score	1.68	.34	.49*	4.99	< .001
	AMMA Composite Score	-.04	.06	-.07	-.71	= .48
Step 3						
	Gender	.66	2.76	.02	.24	= .81
	Familiarity	-2.73	2.99	-.09	-.91	= .36
	ACT Composite Score	1.55	.34	.45*	4.65	< .001
	AMMA Composite Score	-.05	.06	-.08	-.88	= .38
	Sedative condition	1.80	3.17	.06	.57	= .57
	Stimulative condition	7.53	3.23	.26	2.33	= .02

Note. $R^2 = .26$ for Step 1; $\Delta R^2 = .01$ for Step 2 ($p > .45$); $\Delta R^2 = .05$ for Step 3 ($p > .05$).

*$p < .002$

Research Question 1b. Nelson-Denny Reading Rate as Dependent Variable

Research Question 1b asked, after controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the reading rate scores on the *Nelson-Denny Reading Test*?

Table 5

Summary of Hierarchical Regression Analysis for Variables Predicting Nelson-Denny Reading Rate Scores (N = 84)

	Variable	*B*	*SE B*	β	*t*	*p*
Step 1						
	Gender	-5.13	5.09	-.11	-1.01	= .32
	Familiarity	-2.12	5.38	-.05	-.39	= .70
	ACT Composite Score	1.83	.61	.32*	3.02	= .003
Step 2						
	Gender	-5.47	5.07	-.12	-1.08	= .28
	Familiarity	-2.23	5.35	-.05	-.42	= .68
	ACT Composite Score	1.74	.61	.30*	2.87	= .005
	AMMA Composite Score	.14	.11	.14	1.29	= .20
Step 3						
	Gender	-5.06	5.09	-.11	-1.00	= .32
	Familiarity	-.49	5.51	-.01	-.09	= .93
	ACT Composite Score	1.59	.62	.28	2.58	= .01
	AMMA Composite Score	.13	.11	.17	1.20	= .24
	Sedative condition	1.87	5.84	.04	.32	= .75
	Stimulative condition	8.94	5.95	.19	1.50	= .14

Note. R^2 = .12 for Step 1; ΔR^2 = .02 for Step 2 (p > .19); ΔR^2 = .03 for Step 3 (p > .28).
*p < .002

The overall model did not significantly predict reading rate scores on the *Nelson-Denny Reading Test*, $F(6, 77) = 2.55$, $p > .002$. Table 5 reports outcomes by individual variable (see Step 3 of the hierarchical analysis). None of the six independent variables significantly predicted scores on the *Nelson-Denny Reading Test*.

Research Question 1c. D2 Test of Attention as Dependent Variable

Research Question 1c asked, after controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the scores on the *D2 Test of Attention*? The mean test scores for each treatment group are shown in Figure 1.

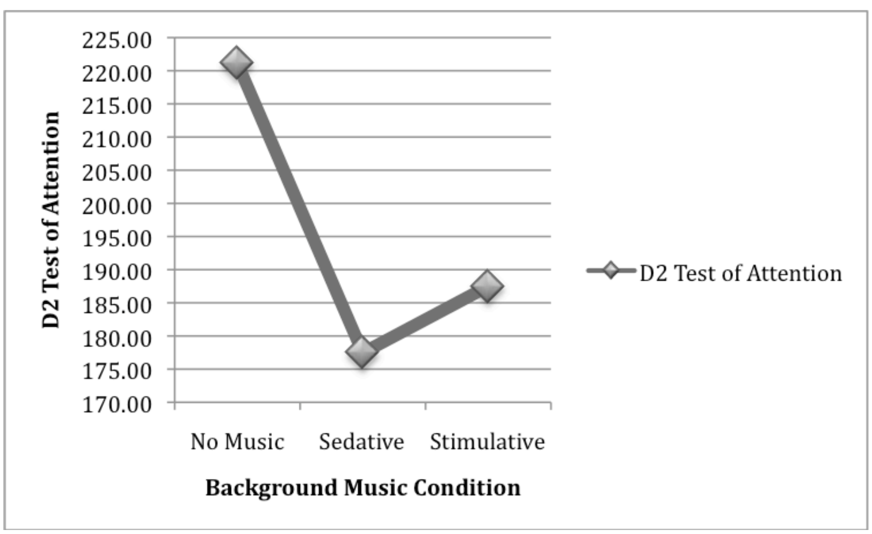

Figure 1. Mean Concentration Performance Scores by Treatment Group.

The overall model significantly predicted concentration performance scores on the *D2 Test of Attention*, $F(6, 77) = 8.06$, $p < .001$. Table 6 reports outcomes by individual variable (see Step 3 of the hierarchical analysis). ACT composite scores and sedative music condition significantly predicted scores on the *D2 Test of Attention*. The stimulative music condition did not meet the stringent level of

Table 6

Summary of Hierarchical Regression Analysis for Variables Predicting D2 Test of Attention Concentration Performance Scores (N = 84)

	Variable	*B*	*SE B*	β	*t*	*p*
Step 1						
	Gender	1.11	8.39	.01	.13	= .90
	Familiarity	-18.82	8.87	-.21	-2.12	= .04
	ACT Composite Score	4.68	1.00	.45*	4.68	< .001
Step 2						
	Gender	1.22	8.46	.02	.14	.89
	Familiarity	-18.78	8.93	-.21	-2.10	= .04
	ACT Composite Score	4.71	1.01	.46*	4.65	< .001
	AMMA Composite Score	-.05	.19	-.03	-.26	= .80
Step 3						
	Gender	3.07	7.84	.04	.39	= .70
	Familiarity	-11.59	8.49	-.13	-1.37	= .18
	ACT Composite Score	4.14	.95	.40*	4.36	< .001
	AMMA Composite Score	-.09	.17	-.05	-.53	= .60
	Sedative condition	-35.76	9.17	-.42*	-3.90	< .001
	Stimulative condition	-25.43	9.00	-.30	-2.83	= .006

Note. $R^2 = .26$ for Step 1; $\Delta R^2 = .001$ for Step 2 ($p > .70$); $\Delta R^2 = .13$ for Step 3 ($p < .01$).
*$p < .002$

statistical significance imposed by the Bonferroni formula (i.e., $p \leq .002$). The stimulative music condition, however, approached statistical significance ($p = .006$).

Research Question 1d. Spatial Ability Test as Dependent Variable

Research Question 1d asked, after controlling for familiarity with the background music, gender, ACT scores, and *AMMA* scores, to what extent does background music condition predict the scores on a test of spatial ability?

The overall model significantly predicted scores on the spatial ability test (Appendix E), $F(6, 77) = 5.76$, $p < .001$. Table 7 reports outcomes by individual variable (see Step 3 of the hierarchical analysis). Of the six independent variables, only the ACT composite score significantly predicted scores on the spatial ability test.

Research Question 2. Self-Reported Frequency of Studying with Background Music

Research Question 2 asked, to what extent do composite *AMMA* scores and scores on measures of reading comprehension, reading rate, attention and spatial ability predict the percentage of time spent listening to music while studying?
The results are shown in Table 8.

A multiple regression analysis was conducted with self-reported percentage of time spent listening to music while studying, as the dependent variable, and composite *AMMA*, reading comprehension, reading rate, attention and spatial ability scores as the predictor variables.

Because frequency of use served as the dependent variable for Research Question 2, there was no reason for a hierarchical analysis in order to control for more

Table 7

Summary of Hierarchical Regression Analysis for Variables Predicting Spatial Ability Scores (N = 84)

	Variable	*B*	*SE B*	β	*t*	*p*
Step 1						
	Gender	.63	.88	.07	.71	= .48
	Familiarity	-.52	.94	-.06	-.56	= .58
	ACT Composite Score	.55	.11	.50*	5.20	< .001
Step 2						
	Gender	.59	.89	.07	.66	= .51
	Familiarity	-.53	.94	-.06	-.57	= .57
	ACT Composite Score	.54	.11	.49*	5.05	< .001
	AMMA Composite Score	.02	.02	.10	1.01	= .32
Step 3						
	Gender	.80	.88	.09	.91	= .37
	Familiarity	-.03	.95	-.00	-.03	= .97
	ACT Composite Score	.53	.11	.49*	4.98	< .001
	AMMA Composite Score	.02	.02	.09	.91	= .37
	Sedative condition	.06	1.01	.01	.06	= .95
	Stimulative condition	-1.88	5.95	.19	-1.87	= .07

Note. R^2 = .26 for Step 1; ΔR^2 = .01 for Step 2 ($p > .32$); ΔR^2 = .04 for Step 3 ($p > .10$).
*$p < .002$

generalized effects (such as general academic achievement). The summary analysis demonstrated that the overall model did not significantly predict self-reported frequency of studying with background music, $F(5, 78) = .59$, $p > .002$. Table 8 reports outcomes by individual variable. None of the five independent variables significantly predicted self-reported frequency of studying with background music.

Table 8

Summary of Regression Analysis for Variables Predicting Frequency of Background Music Use While Studying (N = 84)

Variable	*B*	*SE B*	β	*t*	*p*
AMMA Composite Score	-.06	.17	-.04	-.35	= .73
Nelson-Denny Reading Comprehension Score	-.33	.30	-.14	1.60	= .11
Nelson-Denny Reading Rate Score	.28	.18	.20	.24	= .81
Spatial Ability Test Score	.23	.95	.03	-.29	= .77
D2 Test Concentration Performance Score	-.03	.11	-.04	-1.11	= .27

Note. R^2 = .04

CHAPTER FIVE

DISCUSSION

The questions investigated by this study were related to coefficients influencing musical distraction from four cognitive tasks: a measure of reading comprehension; a measure of reading rate; a measure of concentration; and a measure of spatial ability. The coefficients included: the ability to audiate musical stimuli (as measured by the *AMMA* composite scores), familiarity with the music used in the study, general academic achievement (as measured by the ACT), self-reported frequency of background music use while studying, different background music conditions, age, and gender.

The findings of this study suggest that general academic achievement had a significant positive relationship with reading comprehension, spatial ability, and concentration regardless of background music condition. Furthermore, the sedative music condition had a significant negative relationship on measures of concentration.

Research Questions

Research question one, which covers the main purpose of this investigation, was divided into four sub questions. Each sub question dealt with one of the four cognitive tasks as measured by their corresponding test: 1a) measure of reading comprehension/*Nelson-Denny Reading Test*; 1b) measure of reading rate/*Nelson-Denny Reading Test*; 1c) measure of concentration/*D2 Test of Attention*; 1d) measure of spatial ability/Spatial Ability Test.

The data from each of these hierarchical regressions revealed similar information. The *AMMA* composite scores do not significantly predict background music distraction during the four cognitive tasks regardless of the background music condition (stimulative/sedative/no music). Therefore it seems that the ability to hear and audiate subtle rhythmic and melodic changes is not one of the factors related to the level of distraction caused by background music.

There were also no significant relationships between the variables for gender and familiarity of the music with any of the hierarchical regressions, regardless of the background condition. Therefore all of these variables can be disregarded in the current study.

The ACT composite scores were included in this study to control for general academic achievement. The ACT scores were found to have a statistically significant positive relationship with Research Questions: 1a) *Nelson-Denny* reading comprehension scores; 1c) D2 concentration performance scores; and 1d) spatial ability scores. These results indicate that a measure of general academic achievement should be included in any future study of background music distraction.

It is interesting to note the positive relationship between general academic achievement and success on the four cognitive measures despite the background music condition. Fogelson (1973) found that bright students preferred taking tests with music and non-bright students found the music distracting. Perhaps this is directly related to the complexity of the task. If non-bright students found the task more complex than the bright students, the background music would have more of a negative effect. This would correspond with the results of the current study. Further research needs to be done in this area.

The results for reading comprehension, in Research Question 1a, indicate no significant relationship with background music condition. These results correspond with Kiger, (1989) and Martin, Wogelter, and Forlano (1988). It seems that the presence of background music while reading does not have a detrimental effect on comprehension or reading rate (Research Question 1b). A possible explanation is the almost universal presence of background music in soundtracks for American television and film. The *Nelson-Denny Reading Test* used stories as the material for the questions. The background music may have been perceived as a soundtrack to the narrative, thereby enhancing rather than hindering their concentration on the details of the story. Further research needs to be done in this area.

No significant relationships were found with the spatial ability test (Research Question 1d) other than the ACT composite scores. There were no significant differences among the background music conditions. These results agree with Stephenson (2002).

The results of Research Questions: 1a, 1b, and 1d, strengthen the research on modality and the limited capacity assumption. This line of research posits the theory that background music may have no effect on task performance as long as the task is not in the auditory mode (Boal-Palheiros & Hargreaves, 2004; Eysenck & Keane, 1990).

The hierarchical regression for Research Question 1c was the only analysis that found a significant negative relationship with background music condition. The dependent variable was the *D2 Test of Attention* concentration performance scores. Students in the no music group scored the highest. Scores were lowest during the sedative music condition. Scores in the stimulative music group were also low compared to the no music group (p = .006) though not significant after the Bonferroni correction ($p \leq .002$).

It is interesting that the lowest scores were in the sedative music condition. According to the arousal – mood hypothesis, sedative music reduces the test anxiety caused by hyper–arousal, allowing the subject to perform better on the test than during silence (Campbell, 1996; Dial, 1996; Haynes, 2004; Kiger, 1989; Klackley, 1989). Furthermore, stimulative music increases anxiety according to Fisher and Greenburg (1972). The results of the current study seem to contradict these findings.

The *D2 Test of Attention* is a speed test. Participants have 20 seconds per row to cross out the d's with two dashes; and wrong answers are subtracted from the total correct. It is possible that the sedative music condition slowed the students down through "entrainment" thereby dropping the number of points earned. However, since the stimulative music condition also had a negative relationship, distraction may more likely be the cause.

Another possibility is that the *D2 Test of Attention* was the most complex task for all of the students. "The Yerkes-Dodson law also states that the deterioration occurs more quickly when the task to be performed is complex or under-learned" (Hallam, et. al, 2002, p. 113). Following this law, background music would be least distracting during simple or well practiced tasks such as reading and most distracting during complex or under-learned tasks such as the *D2 Test of Attention* which none of the students had experienced before.

The second research question focused on the relationship between the percentage of time studying with background music present and composite scores on the *AMMA*, reading comprehension, reading rate, concentration performance, and spatial ability tests. This was an effort to check whether students who consistently study with background music performed better than those who do not. The results indicated no significant relationships. In other words, there was no significant difference in test scores between those who consistently study with background music and those who do not. These results may provide some comfort to those concerned about a potential decline in student learning due to the ubiquitous use of mp3 players while studying. More importantly, the results seem to indicate that consistent use of background music does not affect the level of background music distraction from assigned tasks.

In addition to the regression analyses, a Pearson correlation was conducted on all of the variables included in this study. As with the regression models, there was a significant correlation between ACT composite scores and *Nelson-Denny* Reading Comprehension, *Nelson-Denny* Reading Rate, *D2* concentration performance, and spatial ability scores. These results correspond with the analysis of the regression models for Research Question 1.

The *D2* concentration performance scores exhibited statistically significant positive correlations with scores of spatial ability, reading rate, and reading comprehension. These results seem to indicate that the ability to concentrate is related to success on measures of spatial ability, reading rate, and reading comprehension.

Familiarity with the background music had a significant negative correlation with *D2* concentration performance scores. These results demonstrate that participants familiar with the background music used in this study were more likely to be distracted from the *D2 Test of Attention.*

Finally, male participants were significantly more familiar with the background music used than female participants. This effect did not show up during the regression analysis.

Limitations of the Study

One factor affecting this study was the use of free field music instead of headphones. There will always be variations in decibel level throughout a given room. Therefore not all of the students heard the background music at the intended levels. The popularity of ipods means that more students are studying with ear buds or headphones. Perhaps a future study should use headphones so that the students can adjust the volume to their desired level. These volume levels could be monitored with a CRDI type system to determine the levels used at each point in the music and between individuals. However, the use of free field music was realistic to the use of background music in the classroom. Therefore the results from this study should be taken into consideration when used in a classroom setting.

An additional limitation is the short length of time allowed for each test. This may have hidden some of the effects of musical distraction. Each of the cognitive tests should be examined independently and more thoroughly.

Suggestions for Future Research

As always, though the sample size is sufficient for this study, caution should be exercised in making generalizations for the entire population. This study represents an initial investigation into the relationship of musical perception and background music distraction. It is difficult for a single study to incorporate all of the factors related to background music distraction. Therefore many other factors need to be considered in the future. This experiment did not touch on the body of research devoted to personality traits of introversion/extroversion (Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Stanley, 2003; Furnham & Strbac, 2002; Furnham, et al., 1994). Future studies should incorporate this personality trait as one of the factors.

Further research is needed to exam the factors contributing to musical complexity as it relates to distraction. Research on musical complexity could help lead to guidelines on selecting music for classroom use. Additional research is needed on the relationship between academic achievement and musical distraction. If Fogelson (1973) is correct, then general academic achievements could provide guidelines on when and where to use background music in the classroom.

Because of the everyday use of music in the work place, on television, and in the movies, an examination of background music as accompaniment to written narrative is needed to analyze possible benefits in reading comprehension. In addition, research should be conducted on the use of background music during classroom lectures.

Implications

One of the main concerns of this study was the effect of music on reading comprehension. The results of this study suggest that reading comprehension was unaffected by the background music condition. Considering the potential benefits for masking noise and other possible distractions, it is suggested that background music be played during class reading times with careful attention paid to student progress.

Related literature suggests using music with a rising melody and a faster tempo to support higher arousal levels keeping the students awake and alert (Kallinen & Ravaja, 2004; Turino, 1999). The major mode may also cause them to view the reading with a positive attitude (Husain, et al., 2002; Kellaris & Kent, 1992; Oliver, 1997). In addition, it is recommended to use instrumental music. Vocal music is more distracting because it adds an added layer of complexity (Salamé & Baddeley, 1989).

Teachers should be warned against using any background music when trying to accomplish a complex task. The more difficult the task, the more distracting background music becomes (Kaniel, 1998), regardless of individual music aptitudes. The results of this study suggest that slow sedative music is even more distracting than fast stimulative music when administering a timed test. The benefits of sedative music in anxiety reduction would best serve the students if played prior to beginning the test, then turning the music off before giving the test instructions.

Finally, this study found a positive relationship between the ACT composite scores and all three of the cognitive tests administered during the treatment period (*Nelson-Denny Reading Test*/*D2 Test of Attention*/Spatial Ability Test). These scores suggest that general academic achievement is a good predictor for success on other types of cognitive tests. Teachers should be cautious about using background music when teaching new concepts to low achieving students. Although this seems to contradict some previous studies, it may be that the complexity of a new concept is higher for low achieving students than high achieving students. Therefore the background music would be much more distracting for the low achieving students than high achieving students. In order to provide a classroom environment that is beneficial for all students, limit background music use to simple and/or repetitive tasks, small group work and down time.

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APPENDIX A

Human Subjects Committee Approval

KU RESEARCH & GRADUATE STUDIES
The University of Kansas

12/1/2007
HSCL #17027

Michael Dove
1945 E. Greenview St.
Springfield, MO 65803

The Human Subjects Committee Lawrence Campus (HSCL) has reviewed your research project application

17027 Dove/Johnson (MEMT) The Relationship of Rhythmic and Melodic Perception With Background Music Distraction in College Level Students

and approved this project under the expedited procedure provided in 45 CFR 46.110 (f) (7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

The Office for Human Research Protections requires that your consent form must include the note of HSCL approval and expiration date, which has been entered on the consent form sent back to you with this approval.

1. At designated intervals until the project is completed, a Project Status Report must be returned to the HSCL office.
2. Any significant change in the experimental procedure as described should be reviewed by this Committee prior to altering the project.
3. Notify HSCL about any new investigators not named in original application. Note that new investigators must take the online tutorial at http://www.rcr.ku.edu/hscl/hsp_tutorial/000.shtml.
4. Any injury to a subject because of the research procedure must be reported to the Committee immediately.
5. When signed consent documents are required, the primary investigator must retain the signed consent documents for at least three years past completion of the research activity. If you use a signed consent form, provide a copy of the consent form to subjects at the time of consent.
6. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.

Please inform HSCL when this project is terminated. You must also provide HSCL with an annual status report to maintain HSCL approval. Unless renewed, approval lapses one year after approval date. If your project receives funding which requests an annual update approval, you must request this from HSCL one month prior to the annual update. Thanks for your cooperation. If you have any questions, please contact me.

Sincerely,

David Hann

David Hann
Coordinator
Human Subjects Committee - Lawrence

cc: Chris Johnson

Human Subjects Committee Lawrence
Youngberg Hall | 2385 Irving Hill Road | Lawrence, KS 66045 | (785) 864-7429 | Fax (785) 864-5049 | www.research.ku.edu

APPENDIX B

Informed Assent Form

The relationship of rhythmic and melodic perception with background music distraction in college level students.

INTRODUCTION

The Department of Music Education and Music Therapy at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your grade in this class, or the services it may provide to you.

PURPOSE OF THE STUDY

The purpose of this study will be to investigate empirically any relationship between the ability to hear subtle rhythmic and melodic variations in music, and the amount of distraction caused by background music.

PROCEDURES

You will be given a 20 minute music test that will ask you to mark if two musical examples sound the same or different. In another class period you will be given three short tests while either listening to music or working in silence. At the conclusion of the tests you will be given a questionnaire to describe how distracting you found the music or silence. None of these tests will hinder your grade in this class.

RISKS

There are no anticipated risks associated with this study.

BENEFITS

It is hoped that the results of this study will help to further our understanding of the benefits and/or liabilities of background music on task performance.

PAYMENT TO PARTICIPANTS

Participants will not receive payment for their participation in this study.

PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any way with the information collected about you or with the research findings from this study. The researcher will use a study number or a pseudonym instead of your name. The researcher will not share information about you unless required by law or unless you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from Baptist Bible College or to participate in any programs or events at Baptist Bible College. However, if you refuse to sign, you cannot participate in this study.

CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose information collected about you, in writing, at any time, by sending your written request to: Michael Dove, Music Department, Baptist Bible College, 628 East Kearney, Springfield, MO 65803 or mdove@baptist.edu. If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

QUESTIONS ABOUT PARTICIPATION should be directed to:

Michael Dove	Christopher Johnson Ph.D.
Principal Investigator	Faculty Supervisor
Music Department	School of Fine Arts
Baptist Bible College	Murphy Hall
628 East Kearney	University of Kansas
Springfield, MO 65803	Lawrence, KS 66045
(417) 268-6049	(785) 864-3421

If you have any questions about your rights as a research participant you may contact the Human Subjects Committee Lawrence Campus (HSCL) office at 864-7429 or 864-7385 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, email dhann@ku.edu or mdenning@ku.edu.

KEEP THIS SECTION FOR YOUR RECORDS. IF YOU WISH TO PARTICIPATE TEAR OFF THE FOLLOWING SECTION AND RETURN IT TO THE RESEARCHER(S).

The relationship of rhythmic and melodic perception with background music distraction in college level students.

HSCL #____________________ (Provided by HSCL office)

PARTICIPANT CERTIFICATION:

If you agree to participate in this study please sign where indicated, then tear off this section and return it to the investigator(s). Keep the consent information for your records.

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study and the use and disclosure of information about me for the study.

I agree to take part in this study as a research participant.

_______________________________ _____________________

Type/Print Participant's Name Date

____

Participant's Signature

APPENDIX C

PreTest Questionnaire

PreTest Questionnaire

Name____

Age________   Gender: M F

Number of Years in College_______

Is English your primary language? Yes No

By signing I hereby authorize the researcher to use my ACT/SAT scores. I understand that this information will be used for research purposes only and will not be released to anyone not involved in this study both now and in the future.

Signature____________________________ Date___________

APPENDIX D

Post-Test Questionnaire

Post-Test Questionnaire

Name________________________________ Group_______

Circle the answer that most closely represents your opinion.

1. Did you recognize the music? Yes No

2. While you are studying, what percentage of this time is spent listening to music of any kind?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

APPENDIX E

Spatial Ability Test

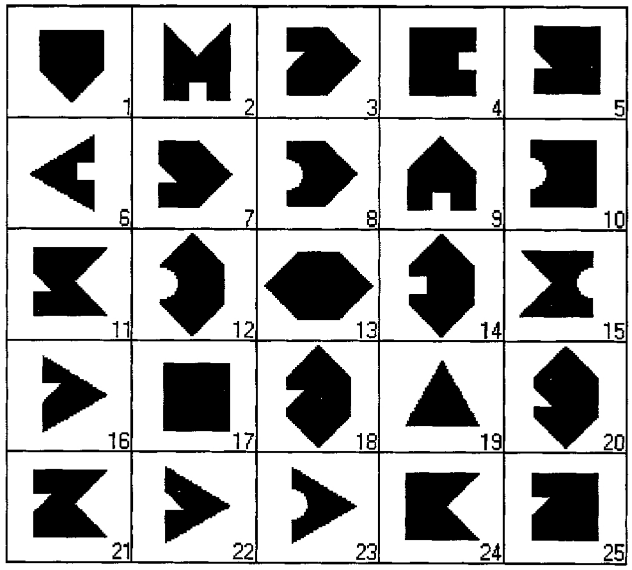
Spatial Ability Test

Adapted from www.psychometric-success.com

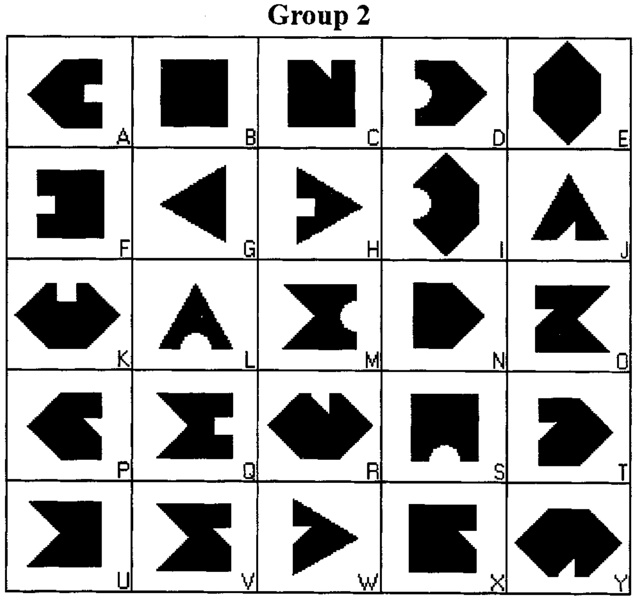
Answer as many questions as you can in 10 minutes.

The shapes in Group 1 and Group 2 are identical, although some of them may be rotated. Which shape in Group 2 corresponds to the shapes (1-25) in Group 1?

Group 1

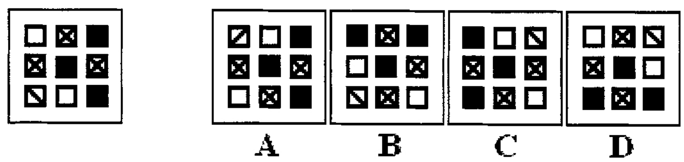


Group 2

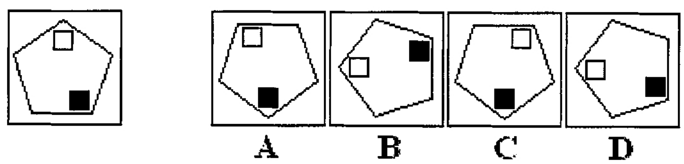


In the figures shown below, one of the shapes (A-D) is identical to the first figure but has been rotated.

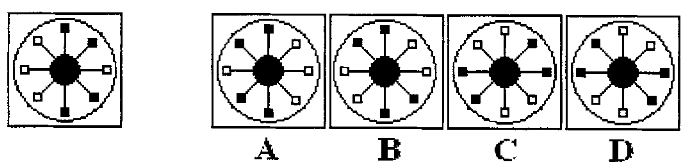
26. Which figure is identical to the first?



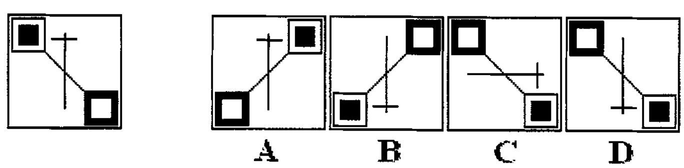
27. Which figure is identical to the first?



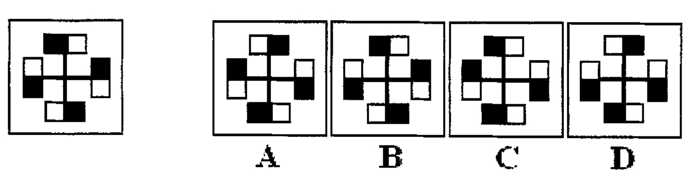
28. Which figure is identical to the first?



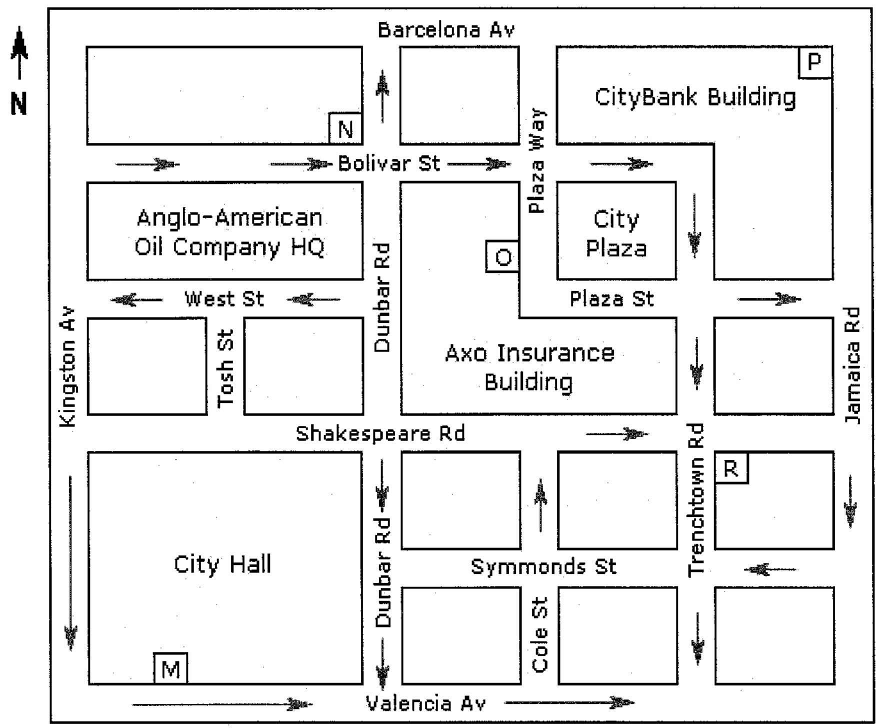
29. Which figure is identical to the first?



30. Which figure is identical to the first?



Use the city map to answer the following questions.



31. Officer Perez is in Tosh St. with City Hall to her right. What direction is she facing?
    A. North
    B. South
    C. East
    D. West
32. She turns and walks to the junction with West St. She then turns right and walks to the next junction before turning left. Where is location 'O' in relation to her position?
    A. North
    B. South
    C. East
    D. West
33. Officer Smith starts from location 'M' and proceeds as follows: left onto Valencia Av – heading East, second left – heading North, second right – heading East, second left – heading North. He proceeds North for two blocks. What is his location?
    A. N
    B. O
    C. R
    D. P

Name___________________________ Group_______

Spatial Ability Test – Answer Form

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.
25.

26.	A	B	C	D
27.	A	B	C	D
28.	A	B	C	D
29.	A	B	C	D
30.	A	B	C	D
31.	A	B	C	D
32.	A	B	C	D
33.	A	B	C	D

Spatial Ability Test – ANSWERS

1. N
2. Q
3. T
4. F
5. X
6. H
7. P
8. D
9. A
10. S
11. V
12. I
13. E
14. K
15. M
16. W
17. B
18. R
19. G
20. Y
21. O
22. J
23. L
24. U
25. C
26. C
27. B
28. A
29. D
30. B
31. C
32. C
33. D

APPENDIX F

Experimental Procedures Task Analysis

Task Analysis for First Day
All Groups

1. Thank everyone for participating in this study.

2. Pass out Informed Assent Form (Appendix B).

3. Review each section of the form.

4. Ask for any questions.

5. Ask them to sign and hand in the last page of the form.

6. Pass out the *AMMA* answer sheet.

7. Turn on the *AMMA* CD. The CD gives the instructions for marking answers, example questions and then continues into the actual test. This part takes 20 minutes.

8. Collect the *AMMA* answer sheets.

Task Analysis for Second Day
Group A

1. Thank everyone for participating in this study.
2. Say: "Before we begin, it is imperative that we turn off all cell phones and pagers. This is a study about musical distraction and cell phones could contaminate the results. Thank you!"
3. Say: "Does anyone need a pencil?"
4. Hand out pencils as needed.

Instructions for *D2 Test of Attention*
Based on test manual instructions.

5. Pass out the *D2 Test of Attention* recording blank.

6. Say: "With the help of the following task, I would like to see how well each of you can concentrate on a particular assignment."

7. Say: "Please look at the front of the recording blank. In the blank labeled "occupation," write "Group A."

8. Say: "Next fill in the rest of the personal information: name, age, gender, dominate hand, education, and date.

9. Say: "Please pay attention. After the word 'Examples' on your recording blank you see three small letters marked with dashes. These are the letter 'd' as in 'dog,' and each is marked with two dashes. The first 'd' has two dashes on the top, the second has two on the bottom, and the third 'd' has one dash on the top and one on the bottom, still making two dashes all together. I would like you to cross out ever letter 'd' that has two dashes by making a single line through the letter. Try doing this first with the three examples, then try the practice line. You are not supposed to cross out the other letters. Thus, a 'd' which has more than two or fewer than two dashes should not be crossed out, and the letter 'p' as in 'pig' should never be crossed out, no matter how many dashes it has. Do you have any questions right now?" (*Pause*).

10. Say: "Let's take a look at whether you have crossed out all the right letters. Every one of the letters in the practice line has a number underneath it. I'll slowly read out the numbers of the letters which you were asked to cross out. You can see whether you have overlooked any of the letters, or whether you perhaps crossed out too many. For example, you were expected to cross out the first letter because it is a 'd' with two dashes on the top, then the third letter because it is a 'd', but this time with

one dash above and one dash below which makes two all together, then the letters numbered 5, 6, 9, 12, 13, 17, 19 and 22. Did you cross out all these numbers? Did anybody cross out more letters or fewer ones? In case you have crossed out a letter which you were not supposed to, you can correct this mistake by crossing the letter out with a second line." Questions? (*Pause*).

11. Say: "Please do not turn your recording blank over yet. Put your pencil down for a moment and listen carefully now. On the other side of your recording blank you will see 14 lines with the same letters you have worked on in the practice line. For each one of the 14 lines you should start on the left side, work to the right and cross out each 'd' with two dashes. This is exactly the same task you did in the practice line. Start with the first line. After 20 seconds I'll say: 'Stop, next line' and you will stop working on that line and immediately start working on the next line. After another 20 seconds I'll say 'Stop, next line' and you will immediately start working on the next line. Work as quickly as you can without making mistakes." (*Pause*).

12. Say: "Now, please turn the page over, so that the first line is on top. In the upper left hand corner you will see an arrow pointing to where you should start working on the first line."

13. Say: "Pick up your pencil and when I give the order start working on the first line."

14. Say: "Ready! Set! Go!"

15. Every 20 seconds say: "Stop, next line".

16. Repeat until all 14 lines are finished.

17. After the last line is completed, say: "Stop. Please hand in your recording blank.

Instructions for *Nelson-Denny Reading Test*
Based on test manual instructions.

1. Pass out the Nelson-Denny answer sheet and booklets.

2. Say: "Please look at the front of the answer sheet. You may use either a pencil or a ballpoint pen. Do not use a felt-tip or other soft marker. Look at the top of the form and fill in the information for name, gender and birth date. Be sure to make an X in the proper box for sex (*Pause*). In the School/College blank, write "Group A" (*Pause*). Make an X in the box for H. Do not tamper with the perforated strip at the edge of the answer sheet."

3. Say: "Do not erase on this answer sheet. If you make a mistake in filling out the information box, draw a line through the error and write in or mark the correct information. If you wish to change an answer, cross our your first answer with an X and mark the answer you now prefer. If you change an answer and later decide that your first answer was correct after all, cross out the second answer and circle the first answer you crossed out earlier; this will indicate that the first answer is the one that should be counted. Are there any questions about changing your answers?" (*Pause*).

4. Say: "Mark all of your answers to the test questions on this answer sheet. Make strong dark marks. Do not mark outside the circles. Make no marks in the test booklet.

5. Say: "Turn over the test booklet to the back cover, which is marked Part II, Comprehension Test. Read the instructions through letter E."

6. Say: "Look at your answer sheet and locate the section at the bottom marked Part II – Comprehension. You will only filling in the 32 answers at the bottom of the answer sheet under Part II – Comprehension. You will have 10 minutes to work on Part II of the test. The first minute will be used to determine your reading rate. Note the section marked Reading Rate. When I tell you to begin, turn the page of the test booklet and start immediately to read the passage on page 8. IMPORTANT, read at your normal rate – neither faster nor slower than usual. At the end of one minute, I will call "Mark." When you hear that signal, stop on the line you are reading. Note the number at the right of that line. Write that number in the row of three boxes under the heading Reading Rate."

7. Show where the number is to be written.

8. Say: "If your reading rate consists of two digits, write 0 (zero) in the first of the three boxes provided. Write the first digit in the middle box and the

second digit in the right-hand box. Then go on immediately with your reading. Before you begin, locate the answer circles for the section marked Part II- comprehension on your answer sheet. This is where you will mark you answers to the questions in the comprehension Test. You will have 10 minutes to complete Part II. Begin when you hear the music start.

9. Start *stimulative* music.

10. Record the starting time.

11. Exactly one minute after the signal to begin, say: "MARK!"

12. Then proceed as follows: "Stop on the line you are reading. Note the number printed at the right of that line. On your answer sheet, write the number as you were directed to do in the three boxes in the section marked Reading Rate. Then go on immediately with your reading."

13. Exactly 10 minutes after the signal to begin, say: "Stop! Close your test booklets. Please hand in your booklets and answer sheets."

Instructions for Spatial Abilities Test

1. Hand out *Spatial Abilities Test* and answer sheet.

2. Say: “Please look at the front of the answer sheet. Fill in your name and put the letter A where it says group.” (*Pause*).

3. Say: “This exam measures your ability to orient objects in space. You will be asked to rotate objects in your mind and to follow directions on a map.”

4. Say: “When the music begins, you will have 8 minutes to finish this test. Are there any questions?” (*Pause*).

5. Start *sedative* music.

6. Record the starting time.

7. Exactly 8 minutes after the signal to begin, say: “Stop! Close your test booklets. Please hand in your booklets and answer sheets and any pencils you borrowed. I need them for the next group.”

8. Say: “Thank you, for participating in this research!”

Task Analysis for Second Day
Group B

18. Thank everyone for participating in this study.
19. Say: "Before we begin, it is imperative that we turn off all cell phones and pagers. This is a study about musical distraction and cell phones could contaminate the results. Thank you!"
20. Say: "Does anyone need a pencil?"
21. Hand out pencils as needed.

Instructions for *Nelson-Denny Reading Test*
Based on test manual instructions.

22. Pass out the Nelson-Denny answer sheet and booklets.

23. Say: "Please look at the front of the answer sheet. You may use either a pencil or a ballpoint pen. Do not use a felt-tip or other soft marker. Look at the top of the form and fill in the information for name, gender and birth date. Be sure to make an X in the proper box for sex (*Pause*). In the School/College blank, write "Group B" (*Pause*). Make an X in the box for H. Do not tamper with the perforated strip at the edge of the answer sheet."

24. Say: "Do not erase on this answer sheet. If you make a mistake in filling out the information box, draw a line through the error and write in or mark the correct information. If you wish to change an answer, cross our your first answer with an X and mark the answer you now prefer. If you change an answer and later decide that your first answer was correct after all, cross out the second answer and circle the first answer you crossed out earlier; this will indicate that the first answer is the one that should be counted. Are there any questions about changing your answers?" (*Pause*).

25. Say: "Mark all of your answers to the test questions on this answer sheet. Make strong dark marks. Do not mark outside the circles. Make no marks in the test booklet.

26. Say: "Turn over the test booklet to the back cover, which is marked Part II, Comprehension Test. Read the instructions through letter E."

27. Say: "Look at your answer sheet and locate the section at the bottom marked Part II – Comprehension. You will only filling in the 32 answers at the bottom of the answer sheet under Part II – Comprehension. You will have 10 minutes to work on Part II of the test. The first minute will be used to determine your reading rate. Note the section marked Reading

Rate. When I tell you to begin, turn the page of the test booklet and start immediately to read the passage on page 8. IMPORTANT, read at your normal rate – neither faster nor slower than usual. At the end of one minute, I will call “Mark.” When you hear that signal, stop on the line you are reading. Note the number at the right of that line. Write that number in the row of three boxes under the heading Reading Rate.”

28. Show where the number is to be written.

29. Say: “If your reading rate consists of two digits, write 0 (zero) in the first of the three boxes provided. Write the first digit in the middle box and the second digit in the right-hand box. Then go on immediately with your reading. Before you begin, locate the answer circles for the section marked Part II- comprehension on your answer sheet. This is where you will mark you answers to the questions in the comprehension Test. You will have 10 minutes to complete Part II. Begin when you hear the music start.

30. Start *sedative* music.

31. Record the starting time.

32. Exactly one minute after the signal to begin, say: “MARK!”

33. Then proceed as follows: “Stop on the line you are reading. Note the number printed at the right of that line. On your answer sheet, write the number as you were directed to do in the three boxes in the section marked Reading Rate. Then go on immediately with your reading.”

34. Exactly 10 minutes after the signal to begin, say: “Stop! Close your test booklets. Please hand in your booklets and answer sheets.”

Instructions for Spatial Abilities Test

9. Hand out *Spatial Abilities Test* and answer sheet.

10. Say: "Please look at the front of the answer sheet. Fill in your name and put the letter B where it says group." (*Pause*).

11. Say: "This exam measures your ability to orient objects in space. You will be asked to rotate objects in your mind and to follow directions on a map."

12. Say: "When I say begin, you will have 8 minutes to finish this test. Are there any questions?" (*Pause*).

13. Say: "Begin."

14. Record the starting time.

15. Exactly 8 minutes after the signal to begin, say: "Stop! Close your test booklets. Please hand in your booklets and answer sheets."

Instructions for *D2 Test of Attention*
Based on test manual instructions.

1. Pass out the *D2 Test of Attention* recording blank.

2. Say: "With the help of the following task, I would like to see how well each of you can concentrate on a particular assignment."

3. Say: "Please look at the front of the recording blank. In the blank labeled "occupation," write "Group B."

4. Say: "Next fill in the rest of the personal information: name, age, gender, dominate hand, education, and date.

5. Say: "Please pay attention. After the word 'Examples' on your recording blank you see three small letters marked with dashes. These are the letter 'd' as in 'dog,' and each is marked with two dashes. The first 'd' has two dashes on the top, the second has two on the bottom, and the third 'd' has one dash on the top and one on the bottom, still making two dashes all together. I would like you to cross out ever letter 'd' that has two dashes by making a single line through the letter. Try doing this first with the three examples, then try the practice line. You are not supposed to cross out the other letters. Thus, a 'd' which has more than two or fewer than two dashes should not be crossed out, and the letter 'p' as in 'pig' should never be crossed out, no matter how many dashes it has. Do you have any questions right now?" (*Pause*).

6. Say: "Let's take a look at whether you have crossed out all the right letters. Every one of the letters in the practice line has a number underneath it. I'll slowly read out the numbers of the letters which you were asked to cross out. You can see whether you have overlooked any of the letters, or whether you perhaps crossed out too many. For example, you were expected to cross out the first letter because it is a 'd' with two dashes on the top, then the third letter because it is a 'd', but this time with one dash above and one dash below which makes two all together, then the letters numbered 5, 6, 9, 12, 13, 17, 19 and 22. Did you cross out all these numbers? Did anybody cross out more letters or fewer ones? In case you have crossed out a letter which you were not supposed to, you can correct this mistake by crossing the letter out with a second line." Questions? (*Pause*).

7. Say: "Please do not turn your recording blank over yet. Put your pencil down for a moment and listen carefully now. On the other side of your recording blank you will see 14 lines with the same letters you have worked on in the practice line. For each one of the 14 lines you should start on the left side, work to the right and cross out each 'd' with two dashes. This is exactly the same task you did in the practice line. Start with the first line. After 20

seconds I'll say: 'Stop, next line' and you will stop working on that line and immediately start working on the next line. After another 20 seconds I'll say 'Stop, next line' and you will immediately start working on the next line. Work as quickly as you can without making mistakes." (*Pause*).

8. Say: "Now, please turn the page over, so that the first line is on top. In the upper left hand corner you will see an arrow pointing to where you should start working on the first line."

9. Say: "Pick up your pencil and when the music starts begin with the first line."

10. Start the *stimulative* music and begin timer at the same time.

11. Every 20 seconds say: "Stop, next line".

12. Repeat until all 14 lines are finished.

13. After the last line is completed, say: "Stop. Please hand in your recording blank and any pencils you borrowed. I need them for the next group."

14. Say: "Thank you, for participating in this research!"

Task Analysis for Second Day
Group C

35. Thank everyone for participating in this study.
36. Say: “Before we begin, it is imperative that we turn off all cell phones and pagers. This is a study about musical distraction and cell phones could contaminate the results. Thank you!”
37. Say: “Does anyone need a pencil?”
38. Hand out pencils as needed.

Instructions for Spatial Abilities Test

16. Hand out *Spatial Abilities Test* and answer sheet.

17. Say: “Please look at the front of the answer sheet. Fill in your name and put the letter C where it says group.” (*Pause*).

18. Say: “This exam measures your ability to orient objects in space. You will be asked to rotate objects in your mind and to follow directions on a map.”

19. Say: “When the music begins, you will have 8 minutes to finish this test. Are there any questions?” (*Pause*).

20. Start the *stimulative* music.

21. Record the starting time.

22. Exactly 8 minutes after the signal to begin, say: “Stop! Close your test booklets. Please hand in your booklets and answer sheets.”

Instructions for *D2 Test of Attention*
Based on test manual instructions.

15. Pass out the *D2 Test of Attention* recording blank.

16. Say: "With the help of the following task, I would like to see how well each of you can concentrate on a particular assignment."

17. Say: "Please look at the front of the recording blank. In the blank labeled "occupation," write "Group C."

18. Say: "Next fill in the rest of the personal information: name, age, gender, dominate hand, education, and date.

19. Say: "Please pay attention. After the word 'Examples' on your recording blank you see three small letters marked with dashes. These are the letter 'd' as in 'dog,' and each is marked with two dashes. The first 'd' has two dashes on the top, the second has two on the bottom, and the third 'd' has one dash on the top and one on the bottom, still making two dashes all together. I would like you to cross out ever letter 'd' that has two dashes by making a single line through the letter. Try doing this first with the three examples, then try the practice line. You are not supposed to cross out the other letters. Thus, a 'd' which has more than two or fewer than two dashes should not be crossed out, and the letter 'p' as in 'pig' should never be crossed out, no matter how many dashes it has. Do you have any questions right now?" (*Pause*).

20. Say: "Let's take a look at whether you have crossed out all the right letters. Every one of the letters in the practice line has a number underneath it. I'll slowly read out the numbers of the letters which you were asked to cross out. You can see whether you have overlooked any of the letters, or whether you perhaps crossed out too many. For example, you were expected to cross out the first letter because it is a 'd' with two dashes on the top, then the third letter because it is a 'd', but this time with one dash above and one dash below which makes two all together, then the letters numbered 5, 6, 9, 12, 13, 17, 19 and 22. Did you cross out all these numbers? Did anybody cross out more letters or fewer ones? In case you have crossed out a letter which you were not supposed to, you can correct this mistake by crossing the letter out with a second line." Questions? (*Pause*).

21. Say: "Please do not turn your recording blank over yet. Put your pencil down for a moment and listen carefully now. On the other side of your recording blank you will see 14 lines with the same letters you have worked on in the practice line. For each one of the 14 lines you should start on the left side, work to the right and cross out each 'd' with two dashes. This is exactly the same task you did in the practice line. Start with the first line. After 20

seconds I'll say: 'Stop, next line' and you will stop working on that line and immediately start working on the next line. After another 20 seconds I'll say 'Stop, next line' and you will immediately start working on the next line. Work as quickly as you can without making mistakes." (*Pause*).

22. Say: "Now, please turn the page over, so that the first line is on top. In the upper left hand corner you will see an arrow pointing to where you should start working on the first line."

23. Say: "Pick up your pencil and when the music starts begin with the first line."

24. Start the *sedative* music and begin timer at the same time.

25. Every 20 seconds say: "Stop, next line".

26. Repeat until all 14 lines are finished.

27. After the last line is completed, say: "Stop. Please hand in your recording blank and any pencils you borrowed. I need them for the next group."

28. Say: "Thank you, for participating in this research!"

Instructions for *Nelson-Denny Reading Test*
Based on test manual instructions.

39. Pass out the Nelson-Denny answer sheet and booklets.

40. Say: "Please look at the front of the answer sheet. You may use either a pencil or a ballpoint pen. Do not use a felt-tip or other soft marker. Look at the top of the form and fill in the information for name, gender and birth date. Be sure to make an X in the proper box for sex (*Pause*). In the School/College blank, write "Group C" (*Pause*). Make an X in the box for H. Do not tamper with the perforated strip at the edge of the answer sheet."

41. Say: "Do not erase on this answer sheet. If you make a mistake in filling out the information box, draw a line through the error and write in or mark the correct information. If you wish to change an answer, cross our your first answer with an X and mark the answer you now prefer. If you change an answer and later decide that your first answer was correct after all, cross out the second answer and circle the first answer you crossed out earlier; this will indicate that the first answer is the one that should be counted. Are there any questions about changing your answers?" (*Pause*).

42. Say: "Mark all of your answers to the test questions on this answer sheet. Make strong dark marks. Do not mark outside the circles. Make no marks in the test booklet.

43. Say: "Turn over the test booklet to the back cover, which is marked Part II, Comprehension Test. Read the instructions through letter E."

44. Say: "Look at your answer sheet and locate the section at the bottom marked Part II – Comprehension. You will only filling in the 32 answers at the bottom of the answer sheet under Part II – Comprehension. You will have 10 minutes to work on Part II of the test. The first minute will be used to determine your reading rate. Note the section marked Reading Rate. When I tell you to begin, turn the page of the test booklet and start immediately to read the passage on page 8. IMPORTANT, read at your normal rate – neither faster nor slower than usual. At the end of one minute, I will call "Mark." When you hear that signal, stop on the line you are reading. Note the number at the right of that line. Write that number in the row of three boxes under the heading Reading Rate."

45. Show where the number is to be written.

46. Say: "If your reading rate consists of two digits, write 0 (zero) in the first of the three boxes provided. Write the first digit in the middle box and the

second digit in the right-hand box. Then go on immediately with your reading. Before you begin, locate the answer circles for the section marked Part II- comprehension on your answer sheet. This is where you will mark you answers to the questions in the comprehension Test. You will have 10 minutes to complete Part II. You may start when I say begin."

47. Say: "Begin".

48. Record the starting time.

49. Exactly one minute after the signal to begin, say: "MARK!"

50. Then proceed as follows: "Stop on the line you are reading. Note the number printed at the right of that line. On your answer sheet, write the number as you were directed to do in the three boxes in the section marked Reading Rate. Then go on immediately with your reading."

51. Exactly 10 minutes after the signal to begin, say: "Stop! Close your test booklets. Please hand in your booklets and answer sheets and any pencils you borrowed. I need them for the next group."

52. Say: "Thank you, for participating in this research!"

APPENDIX G

Raw Data

Ss	Age	Grp	Gdr	ACT	AMMA	Spat Con	Spat Test	Read Con	Read Comp	Read Rate	D2 Con	D2CP	Fam	Frq
1	18	A	0	28	92	1	32	2	184	202	0	257	0	90
2	18	A	0	23	26	1	26	2	169	206	0	227	1	70
3	19	A	1	22	62	1	31	2	187	222	0	209	0	70
4	19	A	1	22	62	1	29	2	184	206	0	232	0	20
5	18	A	0	17	41	1	24	2	167	181	0	224	1	40
6	19	A	0	13	38	1	20	2	167	164	0	154	1	60
7	18	A	1	15	74	1	29	2	161	202	0	223	0	30
8	19	A	0	15	50	1	27	2	153	222	0	209	1	90
9	18	A	1	26	29	1	29	2	172	240	0	276	0	50
10	18	A	0	17	18	1	19	2	169	192	0	200	0	70
11	18	A	0	21	38	1	26	2	181	197	0	240	1	80
12	37	A	1	19	20	1	27	2	161	177	0	186	1	0
13	18	A	0	21	70	1	32	2	164	206	0	257	1	60
14	20	A	1	17	38	1	21	2	184	188	0	199	0	70
15	18	A	1	23	59	1	32	2	167	197	0	236	0	30
16	18	A	0	25	12	1	29	2	178	197	0	232	1	10
17	21	A	0	22	72	1	26	2	184	206	0	174	1	0
18	18	A	0	18	50	1	30	2	172	222	0	237	1	70
19	18	A	1	21	32	1	24	2	169	216	0	132	0	90
20	18	A	1	20	68	1	26	2	153	202	0	285	0	30
21	21	A	0	18	56	1	26	2	161	197	0	265	1	20
22	19	A	0	27	41	1	29	2	181	211	0	258	1	90
23	21	A	0	21	76	1	20	2	178	226	0	142	1	10
24	18	A	0	24	32	1	28	2	190	226	0	273	0	60
25	18	A	0	19	62	1	27	2	175	235	0	146	1	60
26	19	A	0	17	59	1	22	2	178	222	0	194	1	70
27	18	A	0	33	68	1	32	2	193	291	0	266	1	90
28	19	A	1	27	80	1	32	2	169	188	0	258	1	40
29	18	B	0	23	74	0	31	1	175	181	2	169	1	40
30	21	B	0	14	32	0	24	1	164	229	2	164	1	0
31	20	B	0	15	65	0	25	1	142	170	2	167	1	0
32	18	B	0	18	6	0	27	1	164	192	2	230	0	80
33	20	B	0	21	38	0	23	1	184	226	2	213	1	40
34	18	B	0	16	82	0	27	1	161	216	2	181	1	70
35	19	B	0	15	59	0	25	1	158	192	2	200	0	30
36	19	B	1	13	72	0	26	1	147	188	2	148	1	90
37	18	B	1	0	38	0	28	1	175	243	2	241	1	90
38	18	B	0	21	50	0	30	1	156	197	2	178	0	10
39	18	B	1	21	56	0	28	1	169	184	2	167	1	50
40	19	B	1	19	44	0	25	1	164	192	2	147	0	60
41	18	B	0	22	20	0	26	1	167	173	2	205	1	80
42	18	B	0	18	38	0	25	1	147	192	2	209	1	80
43	18	B	0	13	47	0	23	1	164	177	2	192	1	10
44	20	B	0	19	56	0	31	1	164	211	2	203	1	30
45	18	B	1	18	87	0	22	1	147	192	2	177	1	50
46	18	B	0	27	41	0	28	1	178	240	2	186	1	40
47	18	B	0	21	68	0	26	1	132	202	2	195	1	30
48	19	B	1	21	20	0	28	1	203	229	2	254	0	0

Ss	Age	Grp	Gdr	ACT	AMMA	Spat Con	Spat Test	Read Con	Read Comp	Read Rate	D2 Con	D2CP	Fam	Frq
49	19	B	0	0	23	0	22	1	161	177	2	157	1	30
50	18	B	0	23	88	0	31	1	169	192	2	195	0	40
51	18	B	0	18	70	0	20	1	172	226	2	172	0	50
52	18	B	0	18	50	0	23	1	164	184	2	155	0	40
53	23	B	1	22	38	0	27	1	161	181	2	196	1	10
54	19	B	1	21	29	0	23	1	169	181	2	201	0	10
55	18	B	0	25	16	0	25	1	184	211	2	211	1	10
56	18	B	1	18	32	0	25	1	169	177	2	137	1	10
57	18	C	1	13	50	2	13	0	156	226	1	166	1	50
58	18	C	0	0	38	2	21	0	158	202	1	160	1	20
59	18	C	0	22	76	2	26	0	150	192	1	167	1	0
60	19	C	0	18	20	2	26	0	161	197	1	162	1	0
61	18	C	0	19	70	2	14	0	178	188	1	168	1	50
62	18	C	0	26	32	2	33	0	145	177	1	167	1	100
63	19	C	0	14	6	2	22	0	150	181	1	173	1	0
64	19	C	1	25	72	2	28	0	178	206	1	254	1	10
65	18	C	1	17	41	2	26	0	167	246	1	172	1	80
66	26	C	1	0	68	2	28	0	169	197	1	186	1	100
67	19	C	1	19	50	2	30	0	167	173	1	169	1	80
68	19	C	1	13	65	2	26	0	147	177	1	160	0	90
69	19	C	1	14	20	2	15	0	140	173	1	173	0	80
70	18	C	0	25	62	2	27	0	203	222	1	251	0	0
71	19	C	0	19	26	2	21	0	156	206	1	102	1	50
72	22	C	0	19	16	2	28	0	147	188	1	175	1	50
73	19	C	1	21	32	2	15	0	161	202	1	164	1	100
74	19	C	0	23	47	2	28	0	169	216	1	254	1	30
75	25	C	0	17	65	2	19	0	172	216	1	94	1	90
76	18	C	0	22	56	2	22	0	172	197	1	137	1	30
77	18	C	0	25	38	2	31	0	161	202	1	199	0	70
78	18	C	0	20	16	2	24	0	175	166	1	201	1	100
79	18	C	0	21	59	2	23	0	161	197	1	187	1	40
80	22	C	1	24	87	2	24	0	167	181	1	186	1	20
81	18	C	0	21	74	2	25	0	156	202	1	180	1	40
82	19	C	0	0	68	2	24	0	156	243	1	195	1	80
83	19	C	1	21	29	2	31	0	187	173	1	200	1	10
84	19	C	1	16	38	2	30	0	161	164	1	167	1	80

KEY:

Ss = Students

Gdr = Female (1)/Male (0)

Grp = Groups (A, B, C)

Fam = Familiar (0=No; 1=Yes)

AMMA Comp = AMMA Composite Score

ACT Comp = ACT Composite Score

D2CP = D2 Concentration Performance

Frq = Frequency of background music use

Spat Con = Spatial Test Music Condition (0=No Music; 1=Sedative; 2=Stimulative)

Read Con = Reading Tests Music Condition (0=No Music; 1=Sedative; 2=Stimulative)

D2 Con = D2 Test Music Condition (0=No Music; 1=Sedative; 2=Stimulative)