

MUSIC HELPS ME DO MY HOMEWORK: A STUDENT'S CONUNDRUM

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ABSTRACT

Past research has demonstrated that music often negatively impacts performance on a variety of cognitive tasks, including tasks relevant to academia. However, there are discrepancies in the literature, including a handful of instances where no effect of music is observed. The present study tests the novel hypothesis that working memory capacity moderates the effect of music on the performance of academic tasks. Undergraduate students worked on reading comprehension and math tasks under both music and silence conditions, before completing a battery of working memory assessments. While music led to a significant decline in performance overall, working memory capacity moderated this effect in the reading comprehension tasks. These findings suggest that individuals who are better able to control their attention (as indexed by working memory performance) may be protected from music-related distraction when studying certain kinds of material.

DEDICATION

This work is dedicated to my beautiful wife, my loving parents, and my brilliant younger brother; as they have each uniquely contributed to my avoiding a life of vagrancy. Moreover, I am forever grateful to God, who literally saved me at the age of 14. I live on borrowed time, and hope to always reflect that in my passion.

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CHAPTER I

INTRODUCTION

Instructors of undergraduate psychology courses often inform their students of a finding that studying while listening to music hinders learning (Anderson & Fuller, 2010; Doyle & Furnham, 2012; Furnham & Bradley, 1997; Henderson, Crews & Barlow, 1945; Kantner, 2009; Mayfield & Moss, 1989; Parente, 1976; Perham & Currie, 2014; Tucker & Bushman, 1991; Woo & Kanache, 2005). Thus, the advice students often receive is that they ought not to attempt any sort of academic work while listening to music. Many students, however, profess a distrust of such a finding, and retain a belief that they in fact do better with music, despite evidence to the contrary (Anderson & Fuller, 2010; Mayfield & Moss, 1989; Mowesian & Heyer, 1973). An important question is whether any individual difference factor moderates the detrimental effects of music on learning. One potentially relevant moderating factor is working memory function. Working memory is a system for temporarily storing and manipulating information that relies on an attentional control mechanism for regulating the active component of memory (Baddeley & Hitch, 1974; Engle, 2002; Unsworth & Engle, 2007). The present study examines the potential moderating effect of individual differences in working memory capacity on the often observed distracting effect that music has on cognitive performance. This ability may prove useful in predicting the degree to which music impedes the performance of academic tasks.

CHAPTER II

LITERATURE REVIEW

Previous endeavors to observe an effect of music on academic and basic cognitive tasks have produced mixed results. Many studies demonstrate notable declines in performance when in the presence of music relative to a silence condition (Anderson & Fuller, 2010; Doyle & Furnham, 2012; Furnham & Bradley, 1997; Henderson et. al., 1945; Kantner, 2009; Mayfield & Moss, 1989; Parente, 1976; Perham & Currie, 2014; Tucker & Bushman, 1991; Woo & Kanache, 2005), though a subset of these studies yielded inconsistent results. For example, music was detrimental to performance on some, but not all, tasks (Kantner, 2009; Tucker & Bushman, 1991), and the volume (Woo & Kanache, 2005) or style of music (Henderson et. al., 1945; Kantner, 2009; Mayfield & Moss 1989; Woo & Kanache, 2005) being played was a determining factor of whether or not music affected performance. Other studies have failed to observe an effect of music on performance all together (Abikoff, Courtney, Szeibel & Koplewicz, 1996; Freeburne & Fleischer, 1952; Judde & Rickard, 2010; Mowsesian & Heyer, 1973; Pool, Koolstra & Van Der Voort, 2003). Taken together, these studies suggest that while music does seem to negatively impact cognitive performance in many instances, there are exceptions to this general pattern that warrant further exploration.

Discrepancies within the literature could have several explanations. First, there has been a noticeable degree of variability between studies with respect to both the type of music and dependent measures used. One of the earliest studies of the music effect, revealed no evidence of detriments to participant performance (Freeburne and Fleischer, 1952). Notably, Freeburne and Fleischer (1952) employed only instrumental music, which along with classical music has now

been shown on several occasions to have no significant effects on performance (Henderson et. al., 1945; Judde & Rickard, 2010; Kantner, 2009; Woo & Kanache, 2005). On the other hand, in many of these studies more popular music and music with lyrics did hinder performance (Henderson et. al., 1945; Kantner, 2009; Woo & Kanache, 2005). Additionally, music ceased to be distracting when played at a sufficiently quiet volume (Woo & Kanache, 2005), and music with a slower pace was more distracting than fast paced music (Mayfield & Moss, 1989). Differing moods, brought about by listening to music prior to attempting a task, have also been shown to affect performance (Pacheco-Unguetti & Parmentier, 2013); however, this factor has often been ignored in the music distraction literature. Indeed, Pacheco-Unguetti and Parmentier (2013) demonstrated that music, which caused participants to experience sadness, resulted in significantly slower responding among participants on an auditory-visual oddball task relative to when a neutral mood was initiated.

While some studies have examined the effect of music on laboratory-based cognitive tasks such as the oddball task (Pacheco-Unguetti & Parmentier, 2013) and list learning (Judde & Rickard, 2010; Pool et. al., 2003; Woo & Kanache, 2005), many others have used more naturalistic tasks that specifically measure academic skills. The most commonly used academically relevant task is a reading comprehension assessment (Anderson & Fuller 2010; Doyle & Furnham, 2012; Freeburne & Fleischer, 1952; Furnham & Bradley, 1997; Henderson et. al., 1945; Perham & Currie, 2014; Pool et. al., 2003; Tucker & Bushman, 1991). Only in the cases of Tucker and Bushman (1991) and Pool and colleagues (2003) was reading comprehension performance not affected by music.

Another academically relevant task studied in the music distraction literature is performance on arithmetic, though this has yielded mixed results. In some studies arithmetic

performance decreased during a music condition (Mayfield & Moss, 1989; Tucker & Bushman, 1991), while in other studies music seemingly had no effect on participants' ability to solve arithmetic problems (Abikoff et. al., 1996; Mowsesian & Heyer, 1973). A potential explanation for these discrepant findings is that different measures of a given construct (such as reading comprehension on the SAT vs. the GRE) are used between studies. It is also possible, however, that task-specific variations between studies may not fully explain why a music distraction effect was not observed in select cases (Abikoff et. al., 1996; Mowsesian & Heyer, 1973).

The present study focuses on a second potential explanation: that individual differences in working memory capacity moderate the distracting effect of music. Working memory capacity is predictive of a variety of cognitive abilities including, but not limited to, executive attention; which facilitates an individual's ability to keep relevant items within conscious awareness (Bell, Röer, Dentale, & Buchner, 2012; Engle, 2002; Kane, Bleckley, Conway & Engle, 2001; Kane & Engle, 2003; Poole and Kane, 2009; Redick, 2014; Unsworth & Engle, 2007). The predictive utility of working memory capacity has often been demonstrated by comparing performance on a criterion construct between the 25% of individuals who exhibit the highest scores on tests of working memory (high spans) to the 25% of individuals scoring on the lower end of working memory tests (low spans). Of particular relevance to the theoretical motivation for the present study, is research demonstrating that high span individuals are better able to control their attention relative to low spans. In one such study, Kane and colleagues (2001) compared low span and high span individuals on prosaccade and antisaccade tasks. On the prosaccade task, attention-drawing stimuli facilitated performance of the task by drawing the gaze of participants towards the portion of the visual field where the target cue will occur momentarily. On this task both high span and low span persons performed similarly. However, in the antisaccade task the

same stimuli were used to direct attention and visual orientation away from goal-oriented information, and thereby hinder task performance. A failure to employ attentional control in the antisaccade task resulted in slowed responses to the target stimuli. High span individuals demonstrated an increased ability to ignore the distracting stimuli, leading to them outperforming their low span counterparts.

Similarly, Kane and Engle (2003) found that high working memory span individuals benefited from an increased ability to tune out distracting information when performing the Stroop task (Stroop, 1935). On incongruent Stroop trials (i.e., the word and the color of the ink do not match) participants must rely on executive attention to respond correctly (Kane & Engle, 2003). A large number of congruent trials (i.e., the word and the color of the ink match) encourages participants to rely on the written word, leading to higher error rates when incongruent trials do occur. Kane and Engle (2003) found that when trials on the Stroop task were frequently congruent, it was high span participants that best exhibited attentional control in ignoring the distracting incongruent stimuli; again demonstrating a relationship between working memory capacity and executive attention. The rationale for this relationship was that individuals high in working memory were better equipped to effectively focus on the target stimulus in the presence of an unexpected misleading stimulus.

In another series of experiments, Poole and Kane (2009) demonstrated the predictive utility of working memory capacity by treating it as a continuous factor rather than by using an extreme groups design. Poole and Kane (2009) presented participants with a 5 x 5 matrix, and told them at which points the target stimulus could appear (between 1 and 8 locations across experiments). In some instances the stimuli appearing on the matrix were judged to be more distracting, consisting of a range of shapes. Poole and Kane (2009) found that when the visual

search task contained distracting stimuli, higher working memory predicted greater success in using executive control to efficiently locate target stimuli. This was not the case when trials did not include the distracting stimuli (only simple dots). Working memory predicted success in the presence of distracting stimuli regardless of the number of locations where the target stimulus could occur (between 1 and 8). What Poole and Kane's (2009) findings illustrated is that working memory capacity is associated with executive attention abilities along a continuum, and not just when participants are divided into extreme groups. Similar to the distracting stimuli preceding the target cue in the antisaccade task, an incongruent word-ink color pairing on the Stroop task, and distracting stimuli in a visual search task; music represents a distracting stimulus for students engaged in an academic task. In a typical music distraction task, participants must work on a given task while also regulating the level of attention paid to music. It is, therefore, likely that susceptibility to the distracting effects of music will differ as executive attention varies across the continuum of working memory capacity.

Another avenue of study within the music distraction literature has been the frequency with which students choose to listen to music while studying or doing homework of their own volition. Indeed, it is often the case that many students prefer to listen to music at least some of the time while working on school assignments (Anderson & Fuller, 2010; Mayfield & Moss, 1989; Mowesian & Heyer, 1973). Given the growing evidence that this is not an optimal condition for completing academically relevant work (Anderson & Fuller, 2010; Doyle & Furnham, 2012; Furnham & Bradley, 1997; Henderson et. al., 1945; Kanache, 2005; Kantner, 2009; Mayfield & Moss, 1989; Parente, 1976; Perham & Currie, 2014; Tucker & Bushman, 1991; Woo & Kanache, 2005), this behavior likely represents a deficiency in metacognition. Metacognition can be generally understood as thinking about thinking, and includes one's ability

to regulate one's own mental processes and activity (Flavell, 1979). Anderson and Fuller (2010) post-experimentally surveyed their participants' preferences for studying to assess how often they chose to listen to music while studying or doing homework. Interestingly, after controlling for the effect of condition (silence vs. music) on a reading comprehension task, participants that preferred to listen to music when studying did markedly worse on the reading comprehension assessment. This finding alludes to a relationship between the music distraction effect and metacognitive abilities. Specifically, those that are less aware of how music is affecting their performance are more susceptible to the detrimental effects of music. Replicating this finding was one the goals of the present study.

It was hypothesized that working memory capacity would moderate the effects of music on the performance of academically relevant tasks. Specifically, it was predicted that individuals with greater working memory capacity would be less susceptible to the distracting effects of music than those with lesser working memory capacity. Such a finding would facilitate a unifying explanation for inconsistencies within the music distraction literature. Additionally, this project sought to replicate the finding that working memory capacity is strongly linked to metacognitive abilities (Dunlosky & Kane, 2007; Thomas et. al., 2012) by demonstrating that individuals with higher working memory capacity would self-select to listen to less music when completing academically relevant tasks.

CHAPTER III

METHOD

Participants and Design

Participants ($n = 137$) consisted of University of Tennessee at Chattanooga undergraduate students, ranging from 18 to 30 years of age ($M = 19.03$). The majority of participants (78%) identified themselves as being undecided or majoring in something other than psychology.

Participants were recruited from undergraduate psychology courses using the SONA system and received extra credit for participation. A 2 (Task: math vs. reading comprehension) x 2 (Auditory condition: music vs. silence) x 2 (Order: music condition first vs. silence condition first) mixed-model design was used. Within-participant manipulations of music and task required participants to work through two different academically relevant tasks during both the presence of music and silence. A between-participants manipulation of order (music condition first: $n = 82$ vs. silence condition first: $n = 56$) was used to control for any potential effects of the order in which participants completed their work in the music and silence conditions.

Materials

A list of questions consisting of arithmetic (Abikoff et. al., 1996; Mayfield & Moss, 1989; Mowsesian & Heyer, 1973; Tucker & Bushman, 1991) and reading comprehension problems (Anderson & Fuller 2010; Doyle & Furnham, 2012; Henderson et. al., 1945; Freeburne & Fleischer, 1952; Furnham & Bradley, 1997; Perham & Currie, 2014; Pool et. al., 2003; Tucker

& Bushman, 1991) was acquired from a Scholastic Aptitude Test (SAT) practice book to test participants' ability to perform academically relevant tasks under a music and a silence condition. SAT questions were used because: 1) the SAT consists of educationally relevant tasks, and 2) good performance variability could be expected. Additionally, three separate computerized measures of working memory were employed to create a more reliable assessment of working memory capacity, and a composite measure was created based on participant's average z-scores across the three tasks. This composite score was derived from performance on the modified lag task (Shelton, Metzger, & Elliot, 2007), the automated operation span-task (Unsworth, Heitz, Shrock, & Engle, 2005), and the letter number sequencing task (Gold, Carpenter, Randolph, Goldberg, & Weinberger, 1997). All three measures of working memory were weighted equally. In the modified lag task participants were shown lists of words with either 6 or 8 items per list. At the end of each list participants were asked to recall the word "n" back (last word, 1-back, 2-back, or 3-back). The task required participants to continually update a changing list of words and to be ready at any point to recall a given word from the list. During the automated operation span task participants solved arithmetic equations, with each equation being immediately followed by a letter that was to be remembered. At the end of the series of equations participants were assessed on the number of letters they could recall. The letter number sequencing task exposed participants to lists of varying length comprised of both letters and numbers. Participants were asked to respond at the end of the lists with the letters and then numbers in alphabetical and numerical order.

Metacognition was assessed in two ways. First, participants were asked to predict how well they would perform on the arithmetic and reading comprehension tasks on a scale of 1-100 (Miller & Geraci, 2011). All participants were informed of the impending type of trial (music vs.

silence) before they made their metacognitive predictions. Second, a post-experimental questionnaire was administered to assess study habits and music listening preferences (Anderson and Fuller, 2010). Students were asked to describe the proportion (1-100%) of time they typically spend listening to music while performing academic activities such as homework, and to describe on a scale of one to nine how much they believe music helps/hurts their performance.

The music played during the music condition consisted of songs randomly selected from the Billboard Top 100, and represented currently popular songs that were familiar to most participants. Using currently popular music with vocals should maximize the distracting effect of the music. Instrumental music has been shown in previous research to be less distracting compared to music with words because of the varying degrees of information one has to selectively inhibit (Fleischer, 1952; Kantner, 2009; Li, Parmentier, & Zhang, 2013). Similarly, popular music has been found to be increasingly distracting for persons when compared to older/less popular music (Henderson et. al., 1945; Woo & Kanachi 2005). To rule out the effects of mood as a confounding variable, participants were given the Positive and Negative Affect Schedule (PANAS) (Watson & Clark, 1994). The PANAS (Watson & Clarke, 1994) consisted of a list of words describing emotional states, and participants were asked to indicate the degree to which each word describes their feelings during the past week.

Procedure

All participants completed the experiment in groups of 2-10 while seated at individual computer stations with Dell desktop computers. The experimental tasks were constructed using E-prime 2.0 (Psychology Software Tools, Pittsburgh, PA). However, participants filled out the informed consent and the PANAS (Watson & Clark, 1994) using pencil and paper prior to the

first trial. Participants responded to the PANAS immediately following the informed consent to assess baseline affectivity (Pacheco-Unguetti & Parmentier, 2013). Next, participants completed arithmetic and reading comprehension problems from the SAT under both silence and music conditions while wearing Sony noise-cancelling headphones. The order of the experimental condition was counterbalanced between participants, as approximately half of the participants completed the SAT problems in the silence followed by the music condition, and the other participants first completed problems in the music condition followed by a silence condition. Each block of either music or silence lasted for 20 minutes. Once participants finished the academic tasks under music and silence conditions they immediately progressed to the three working memory tests. The nature of the present study did not necessitate counterbalancing of the order of these working memory tasks, as they were equally weighted across participants and only the composite score of the three tasks were used for analysis. Additionally, counterbalancing tasks meant to assess individual differences in working memory capacity could lead to order specific effects, hindering the interpretation of relevant data (Redick, 2014). After finishing all experimental trials participants were given a survey to assess their own personal study and homework habits, specifically with regards to music listening habits and preferences (Anderson & Fuller, 2010; Mayfield & Moss, 1989; Mowsesian & Heyer, 1973).

CHAPTER IV

RESULTS

Data Analysis

For all analyses, significance level was set at $\alpha = .05$. Working memory capacity was assessed on a continuum, based on a composite score created from three separate measures of working memory. Raw performance on a given working memory task was transformed into a z-score, and each participant's collection of z-scores was then averaged together to create a measure of working memory capacity. This approach allowed for an analysis of the effect of individual differences in working memory capacity across the spectrum of working memory (Pool & Kane, 2009), as opposed to an extreme groups design (Kane et. al., 2001; Kane & Engle, 2003). The degree to which participants were accurate in predicting their performance on a given task (i.e. accuracy on math questions during the playing of music) was calculated with a calibration score (Thomas et. al., 2012). A participant's accuracy score was subtracted from his or her predicted score, and the absolute value of this number represented how inaccurate the prediction was. Therefore, a score of zero would be a perfectly accurate prediction.

Music Effect and Working Memory

A 2 (Task: math vs. reading comprehension) x 2 (Auditory condition: music vs. silence) x 2 (Order: music condition first vs. silence condition first) mixed-model Analysis of Covariance (ANCOVA) was used with working memory capacity as a covariate to predict accuracy on the

academically relevant tasks. A main effect of auditory condition was observed $F(1, 135) = 12.38$, $p < .05$, $MSE = .29$, $\eta^2 = .08$. Participants were found to perform worse on the math task during the playing of music ($M = .38$, $SD = .19$) than during silence ($M = .44$, $SD = .20$), and similarly, they were worse on the reading comprehension task during music ($M = .38$, $SD = .18$) than during silence ($M = .41$, $SD = .16$). Furthermore a main effect of working memory capacity $F(1, 135) = 25.73$, $p < .05$, $MSE = 1.37$, $\eta^2 = .16$ revealed that as participants' working memory capacity increased, performance increased. Performance did not vary significantly between tasks $F(1, 135) = 1.23$, $p > .05$, $MSE = .03$, $\eta^2 = .01$, nor did performance vary between order conditions $F(1, 135) = .06$, $p > .05$, $MSE = .003$, $\eta^2 = .000$. Importantly, there was a qualifying three-way interaction between auditory condition, task, and working memory capacity $F(1, 135) = 4.00$, $p < .05$, $MSE = .08$, $\eta^2 = .03$ (see Figure 4.1). Separate linear regression analyses were conducted for the reading comprehension and math tasks to follow up this interaction. Difference scores (silence minus music) were used as the dependent measures with working memory composite scores used as the predictor. The first analysis revealed that as working memory capacity increased, the difference in performance on the reading comprehension task between music and silence conditions was less pronounced $b = .17$, $t(135) = 2.03$, $p < .05$, $r^2 = .03$. A separate linear regression analysis revealed that this was not the case on the math task $b = -.05$, $t(135) = -.58$, $p > .05$, $r^2 = .002$. Thus, the observed three-way interaction was driven by working memory capacity moderating the music distraction effect in the reading comprehension but not the math task.

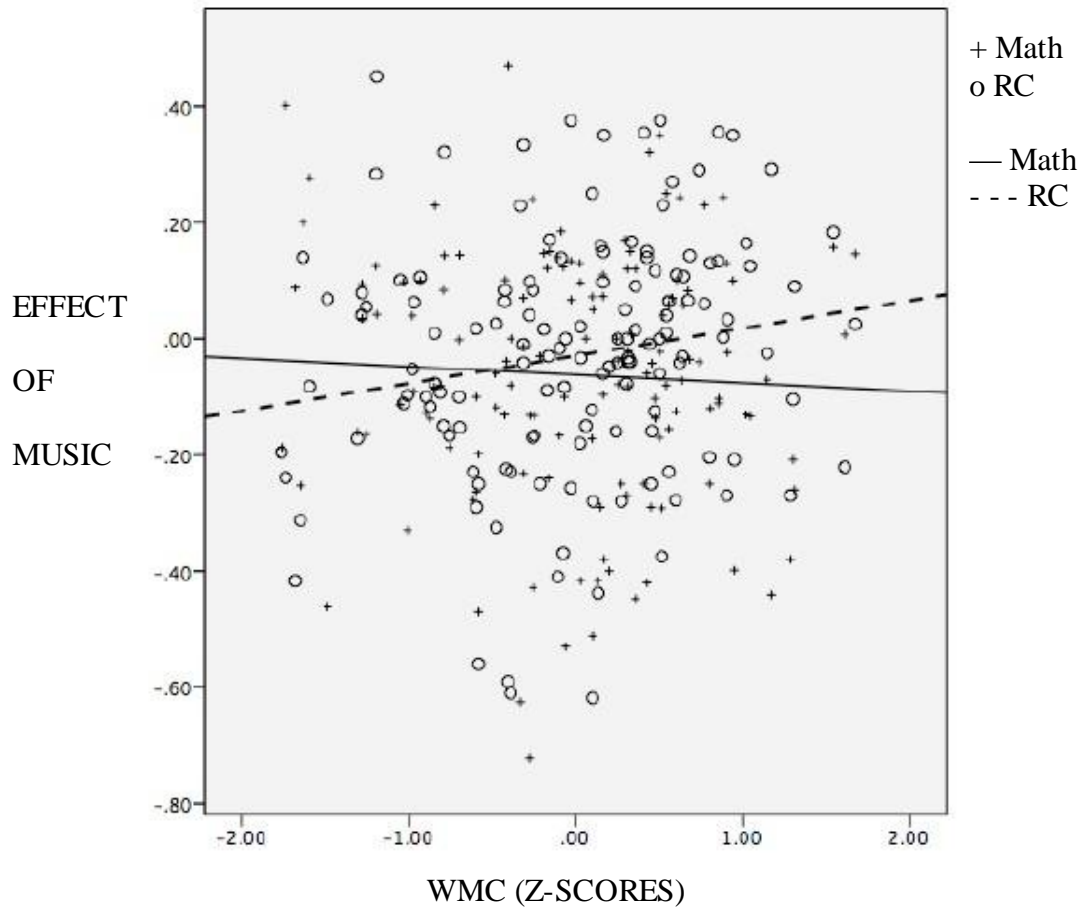


Figure 4.1 The moderating role of working memory capacity in music’s effect on performance

Affective States

The difference scores between the music and silence conditions on the math and reading comprehension tasks were used to facilitate analyzing the influence of different affective states as measured by the PANAS. Bivariate correlation analyses revealed no link between the difference scores representing the effect of music on task performance, and constructs measured by the PANAS. These constructs included: general negative affect, general positive affect, fear, sadness, guilt, hostility, shyness, fatigue, joviality, self assurance, attentiveness, serenity, and surprise (all p 's > .05). For all PANAS statistics see Table 4.1.

Table 4.1 Participant affective state as measured by the PANAS

	Mean Proportion	Standard Deviations
General Negative Affect	0.37	0.15
General Positive Affect	0.38	0.18
Fear	0.32	0.15
Sadness	0.35	0.13
Guilt	0.36	0.14
Hostility	0.63	0.19
Shyness	0.66	0.18
Fatigue	0.58	0.17
Joviality	0.69	0.15
Self Assurance	0.62	0.19
Attentiveness	0.44	0.19
Serenity	0.38	0.13
Surprise	0.65	0.15

Metacognition

A paired samples t-test of participants' predictions of their performance on the arithmetic task during music ($M = 38.04$, $SD = 23.24$) and during silence ($M = 39.60$, $SD = 23.68$) revealed no significant difference in how well participants thought they would do $t(137) = -.915$, $p > .05$. Similarly, a paired samples t-test of music ($M = 44.25$, $SD = 27.78$) and silence ($M = 44.80$, $SD = 28.33$) conditions revealed no effect of condition on the reading comprehension task $t(137) = -.732$, $p > .05$. A paired samples t-test of how accurately participants predicted their performance during the music condition ($M = .22$, $SD = .18$) and the silence condition ($M = .25$, $SD = .17$) on the arithmetic task revealed that participants were no more accurate in estimating their

performance in either condition, $t(136) = -1.26, p > .05$. Similarly, no effect was found when comparing the accuracy of predictions during music ($M = .26, SD = .21$) and silence ($M = .27, SD = .19$) on the reading comprehension task $t(137) = -.49, p > .05$. Furthermore, working memory capacity was not significantly correlated to the accuracy of predictions for the arithmetic questions under music $r(137) = -.04, p > .05$, or silence $r(138) = .08, p > .05$. Also, working memory capacity was not significantly correlated with the accuracy of predictions for the reading comprehension questions under music $r(138) = .00, p > .05$ or silence $r(138) = -.02, p > .05$. In addition, the self-reported percentage of time that participants listen to music while doing academically relevant tasks, such as homework, was not significantly related to any potentially relevant factors such as the effect of music on the math $r(135) = -.03, p > .05$ or reading comprehension $r(135) = .10, p > .05$ tasks, or working memory capacity $r(135) = -.009, p > .05$. Similarly, the degree to which participants believed that music affected them was not significantly correlated to the effect that music had on their math $r(135) = -.07, p > .05$ or reading comprehension $r(135) = .01, p > .05$ performance.

CHAPTER V

DISCUSSION

The present study replicates previous research demonstrating that performance of academically relevant tasks will suffer under a music condition compared to a silence condition (Anderson & Fuller, 2010; Doyle & Furnham, 2012; Furnham & Bradley, 1997; Henderson et. al., 1945; Kantner, 2009; Mayfield & Moss, 1989; Parente, 1976; Perham & Currie, 2014; Tucker & Bushman, 1991; Woo & Kanache, 2005). Importantly, the present findings offer an exciting extension to this line of research by offering a novel explanation for why some have failed to observe the music distraction effect, as individual differences in working memory capacity had not previously been considered as a moderator. The implication is that, indeed, some students are right in their assumption that it is relatively safe for them to listen to music while doing their homework, though no evidence has been found to suggest that individuals will do better when listening to music compared to silence. Specifically, individuals with higher working memory abilities can perform reading comprehension tasks just as well when they are listening to music relative to performing the task in silence; however, working memory ability does not protect these individuals against music-related distraction in math tasks.

It is not surprising that individuals with higher working memory capacity can safely perform reading comprehension tasks while listening to music. People with greater working memory can be expected to better employ executive attention skills (Bell et. al., 2012; Engle, 2002; Kane et. al., 2001; Kane & Engle, 2003; Redick, 2014; Unsworth & Engle, 2007),

allowing for the effective reading and processing of the task relevant information under either auditory condition (music or silence). It was predicted that high working memory capacity would similarly facilitate performing on arithmetic tasks, regardless of the auditory condition; however, the failure to observe this finding could reflect the fact that arithmetic tasks are supported by different cognitive processes than reading comprehension tasks. Reading comprehension tasks involve encoding information into long-term memory (Atkinson & Shiffrin, 1968), a process not necessarily inherent in completing arithmetic tasks. Indeed, past research has demonstrated that higher verbal working memory capacity was specifically associated with better reading comprehension for a sample of college-aged participants (Daneman & Carpenter, 1980). The findings from the present study replicate and extend this basic pattern as working memory capacity was not only associated with performance on the reading comprehension test but it also accounted for significant variability in the observed difference in reading comprehension in the presence of music versus silence. Notably, all of the working memory tasks used in the present study were verbal in nature, which could have diminished their predictive utility for the more spatially driven math task. Consistent with this premise, children with specific arithmetic deficits revealed significantly lower scores on the spatial, but not verbal, component of working memory relative to children with no specific arithmetic deficits (McLean, & Hitch, 1999). Thus, a fruitful direction for future research is to investigate whether individual differences in spatial working memory capacity could, indeed, moderate the music distraction effect that is sometimes observed in math tasks.

One potentially troublesome finding from a naturalistic perspective was that no relationship was observed between working memory capacity and how often participants self-select to listen to music while working on academically relevant tasks. Contrary to what

Anderson and Fuller (2010) found, our results suggest that while some individuals can do their homework and listen to music at the same time, people seem to be fairly oblivious regarding what camp they fall into. The current study had an older sample than did Anderson and Fuller (2010) who used junior high school students. It may be that by the time students reach college they believe they have developed sufficient strategies for working on academically relevant tasks while listening to music. Furthermore, the way in which beliefs regarding the effect of music were measured in the present study varied from the study conducted by Anderson and Fuller (2010). Anderson and Fuller (2010) dichotomized their participants by asking only whether or not they listened to music at all while doing homework. Conversely, participants in the present study were asked to report their music listening habits as a percentage, allowing for a more exact representation of behavior. This difference in measurement likely contributed to the contradictory conclusion reached in the current study. It is also worth noting that working memory capacity was surprisingly not predictive of participants' ability to accurately predict their performance on the arithmetic or reading comprehension tasks across auditory conditions. Typically increased working memory has been associated with better metacognitive abilities (Dunlosky & Kane, 2007; Thomas et. al., 2012), but in the present study it was the case that the way in which music impacted performance, represented a blind spot for participants across the spectrum of working memory capacity.

One potential limitation of the present study is the way in which participants' affective state was assessed. An individual's affective state prior to listening to music was not related to their susceptibility to distraction in the presence of music, however, this only partially addresses concerns raised by Pacheco-Unguetti and Parmentier (2013). It is possible that participants' affect was changed by the music, which may have, in turn, impacted the effect of music on

performance. Notably, participants all listened to the same songs, which would have likely led to any effects of music on mood being fairly consistent across participants. Additionally, as has been highlighted previously, there is a notable variety in the type of academically relevant tasks studied under a music manipulation. The present study sought to explore the effect of music on two particularly relevant academic tasks, but in choosing the tasks that we felt would be most telling other tasks were necessarily left out for practical reasons. The tasks used in the present study were selected for their general relevance to a range of academic areas, but certainly other tasks exist, the study of which could contribute valuable knowledge to the process by which music affects academic performance.

In conclusion, for most students it would be a mistake to listen to music while working on academically relevant tasks; however, those with higher working memory capacities may be less vulnerable to performance deficits traditionally associated with listening to music. Unfortunately, no evidence was uncovered to suggest that these individuals know who they are, so many students may listen to music despite the detrimental effects this choice has on their learning. The findings from the present study also have important theoretical implications as they provide one potential explanation for why inconsistencies have been observed in the music distraction literature. Future research is needed to elucidate which other academically relevant tasks are negatively affected by music, and what role is played by individual differences in working memory capacity in accounting for one's susceptibility to music-related distractions.

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VITA

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