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Individual Differences in Working Memory Predict the Effect of Music on Student Performance

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Past research has demonstrated that music often negatively impacts performance on a variety of cognitive tasks, including academically relevant tasks. There are, however, discrepancies in the literature, including a handful of instances where no effect of music was observed. We tested the novel hypothesis that working-memory capacity moderated the detrimental effect of music on academic performance. Undergraduate students worked on reading-comprehension and math tasks under both music and silence conditions before completing a battery of working-memory capacity assessments. Although 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 capacity) may be protected from music-related distraction when completing certain kinds of academically relevant tasks.

General Audience Summary

Instructors of undergraduate psychology courses often inform their students of a finding that studying while listening to music hinders learning. 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. An important question then is whether the detrimental effect that music has on learning actually impacts everyone in the same way. The present study examined whether individual differences in people's attention and memory abilities could predict the degree to which music impeded their performance of academic tasks. Interestingly, the higher an individual scored on the tasks measuring attention and memory abilities, the less they were affected by music while they worked on reading-comprehension questions. However, when solving math problems, the detrimental effect of music was similar, regardless of how individuals scored on the tasks measuring memory and attention.

Keywords: Working memory capacity, Music, Auditory distraction, Academic performance

Many studies have demonstrated notable declines in performance on academic tasks completed in the presence of music relative to a silence condition (e.g., Anderson & Fuller, 2010; Henderson, Crews, & Barlow, 1945), although a subset of those 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 & Kanachi, 2005) or style of music (Henderson et al., 1945; Kantner, 2009; Mayfield & Moss, 1989; Woo & Kanachi, 2005) being played was a determining factor in whether or not

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music affected performance. Other studies failed to observe any effect of music on performance (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 there have been exceptions to the typical music-distraction effect that warrant further exploration.

Some studies examined the effect of music on laboratory-based cognitive tasks such as the oddball task (Pacheco-Unguetti & Parmentier, 2014) and list learning (Judde & Rickard, 2010; Woo & Kanachi, 2005), but many others used more naturalistic tasks measuring academic skills. The most commonly used academically relevant tasks have been reading-comprehension assessments (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 Tucker and Bushman (1991) and Pool et al. (2003) reported that reading-comprehension performance was unaffected by music.

The impact of music on arithmetic performance has also yielded mixed results, with some studies revealing a decline in arithmetic performance during a music condition (Mayfield & Moss, 1989; Tucker & Bushman, 1991), and other studies yielding no music-distraction effect (Abikoff et al., 1996; Mowsesian & Heyer, 1973). A potential explanation for these discrepant findings is that the studies used different measures of a given construct (such as reading comprehension on the SAT vs. the GRE). It is also possible, however, that task-specific variations between studies did not fully explain why a music-distraction effect was not observed in select cases.

We tested another potential explanation for the discrepant findings in the music-distraction literature: that individual differences in working-memory capacity (WMC) moderate the distracting effect of music. Performance on WMC tasks has successfully predicted individual differences in a variety of cognitive abilities including executive attention, which facilitates an individual's ability to keep relevant items within conscious awareness while inhibiting irrelevant information (Engle, 2002; Kane, Bleckley, Conway, & Engle, 2001). In one such study, Conway, Cowan, and Bunting (2001) used a version of the dichotic-listening task wherein participants shadowed speech presented in one ear while ignoring speech presented in the other ear. During the task, the participant's name was spoken in the stream of to-be-ignored speech. Afterwards, when participants were asked about hearing their name, individuals with lower WMC were much more likely to have noticed their name being presented. In failing to hear their name, participants who scored in the upper-quartile of WMC demonstrated an increased ability to inhibit the to-be-ignored speech. Music similarly represents a potentially distracting stimulus for students engaged in an academic task.

Another avenue of study has been the frequency with which students choose to listen to music while studying or doing homework of their own volition. Robison and Unsworth (2015) reported that their participants believed they were being distracted when background noise simulating a noisy restaurant was introduced during a reading-comprehension task, but students were less aware of a distracting effect of listening to music. Indeed, many students have reported that they prefer to listen to music at least some of the time while working on school assignments (Anderson & Fuller, 2010). Given the growing evidence that listening to music is not an optimal condition for completing academically relevant work (e.g. Anderson & Fuller, 2010), this behavior may represent a deficiency in metacognition. Metacognition can be generally understood as thinking about thinking, including the ability to regulate one's own mental processes and activity (Flavell, 1979). In one study, Anderson and Fuller (2010) post-experimentally surveyed their participants' preferences to assess how often they chose to listen to music while studying or doing homework. After controlling for the effect of condition (silence vs. music), participants who preferred to listen to music when studying did markedly worse on the reading-comprehension assessment. Thus, individuals who are less aware of how music is affecting their performance may be more susceptible to the detrimental effects of music. Replicating this finding was among the goals of the present study.

We hypothesized that individuals who scored higher on tests of WMC would be less susceptible to the distracting effects of music when performing academic tasks, compared to those with lower WMC scores. Such a finding would facilitate a unifying explanation for inconsistencies within the music-distraction literature. Additionally, we sought to replicate the general finding of a relationship between WMC and metacognitive abilities (Dunlosky & Kane, 2007). Specifically, we predicted that lower WMC individuals would be more likely to choose to listen to music when completing academically relevant tasks.

Method

Participants and design

Participants ($N = 151$) consisted of University of Tennessee at Chattanooga undergraduate students, whose ages ranged from 18 to 30 ($M = 19.03$). The majority of participants (78%) identified themselves as being undecided or majoring in something other than psychology. Participants were recruited from undergraduate psychology courses and received extra credit for participation. Data from a few of these participants was not included for analysis due to a computer issue ($n = 8$), cell phone usage ($n = 3$), and failure to follow instructions ($n = 2$).

A 2 (Task: math vs. reading comprehension) × 2 (Auditory Condition: music vs. silence) × 2 (Order: music condition first vs. silence condition first) mixed-model design was used. Within-participant manipulations of auditory condition and task required all participants to work through two academically relevant tasks during both the presence of music and silence. A between-participants manipulation of order was used to measure any potential effects of the order in which participants completed their work in the music and silence conditions. Because participants completed the experiment in groups, the sample size of each order condition (music condition first: $n = 82$ vs. silence condition first: $n = 56$) was allowed to vary so that all of the participants in a given experimental session would be presented with either music or silence first. During pilot testing the specific academic questions that were presented during the music or

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