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More Than Meets the Ear: Investigating How Music Affects Cognitive Task Performance

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Researchers have documented various (sometimes conflicting) effects of music on cognitive task performance, and have highlighted several mechanisms through which these effects may occur (e.g., arousal, mood, attention). To further understand these effects, we consider interactions between music-based, task-based, and performer-based characteristics. Specifically, we drew from the distraction-conflict theory of social facilitation and research on boredom proneness to hypothesize that music—along with its complexity and volume—facilitates simple task performance and impairs complex task performance, and that one's preference for external stimulation (a dimension of boredom proneness) moderates these effects. We tested our hypotheses in a laboratory experiment, in which participants completed cognitive tasks either in silence or with music of varying complexity and volume. We found that (a) music generally impaired complex task performance, (b) complex music facilitated simple task performance, and (c) preference for external stimulation moderated these effects. Therefore, the data suggest that music's effects on task performance depend on the music, the task, and the performer.

Public Significance Statement
In this study, we found that music generally impaired performance on a complex task, whereas complex music improved performance on a simple task. These effects depended on the task performer's personality, suggesting the need to consider music-, person-, and task-based factors when deciding whether to integrate music into work environments.

Keywords: music, distraction, social facilitation, boredom proneness, task performance

Psychologists have long held an interest in whether music can affect performance on cognitive tasks (henceforth referred to as "task performance"). While researchers have offered explanations for how music affects task performance in certain contexts (e.g., Perham & Sykora, 2012; Rauscher, Shaw, & Ky, 1993; Thompson, Schellenberg, & Husain, 2001), there is nevertheless mixed evidence regarding how music affects task performance more generally (for reviews, see Dalton & Behm, 2007; Kampfe, Sedlmeier, & Renkewitz, 2010; Landay & Harms, 2017; Schellenberg, 2005). Indeed, several research studies offer mixed evidence regarding how music affects task performance, showing that music either facilitated (e.g., Lesiuk, 2005; Rauscher, Shaw, Levine, Ky, & Wright, 1994; Schellenberg & Hallam, 2005; Schellenberg, Nakata, Hunter, & Tamoto, 2007), hindered (e.g., Cassidy & MacDonald, 2007; Furnham & Bradley, 1997; Furnham & Strbac, 2002; Reynolds, McClelland, & Furnham, 2014), or did not affect task performance (e.g., Reynolds et al., 2014; Steele, Brown, & Stoecker, 1999). Better understanding the psychological effects of music listening is particularly important in this current era of technology, in which music is highly accessible through Internet-based streaming services and innovations in mobile technology (The Neilsen Company, 2015).

One possible reason for the mixed findings cited above is that much of the research on music and task performance has not simultaneously examined both task-based and person-based moderators within the same study (see Reynolds et al., 2014, as one such exception). We propose here that researchers may better understand how music affects task performance by investigating how characteristics of (a) the music, (b) the task, and (c) the task performer interact with each other. To this end, we examine how music salience, task complexity, and individual differences in preferences for external stimulation interact to affect task performance. In what follows, we will first review the extant research on music and task performance. Second, we will describe the distraction-conflict theory of social facilitation (Baron, 1986), and conceptualize music within this theory as a type of distraction. Third, drawing from distraction-conflict theory and research on

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boredom proneness, we will propose music-, task- and person-based moderators of the music–task performance relationship and offer hypotheses regarding each.

Music and Task Performance

Rauscher and colleagues' "Mozart effect" was among the first explanations of music's effect on task performance to gain significant scientific attention (e.g., Rauscher et al., 1993, 1994). In these studies, the authors found that participants performed better on spatial–temporal tasks after listening to a Mozart sonata, relative to participants who did not listen to music. The authors posited that music activates regions in the brain that are typically utilized when engaged in spatial–temporal reasoning, thus facilitating short-term performance on spatial–temporal tasks.

Subsequent research has been unable to replicate Rauscher and colleagues' findings (e.g., Carstens, Huskins, & Hounshell, 1995; Steele et al., 1999; Stough, Kerkin, Bates, & Mangan, 1994), casting doubt on the replicability of the Mozart effect. Researchers have since developed alternative explanations regarding how music affects task performance. Two of such explanations that have received significant empirical attention are (a) the mood-arousal hypothesis (e.g., Thompson et al., 2001), and (b) the irrelevant sound effect (ISE; e.g., Jones, 1999).

According to the mood-arousal hypothesis, listening to preferred or enjoyable music increases pleasant mood and arousal levels, which facilitates performance on subsequent cognitive tasks (Schellenberg & Hallam, 2005). The mood-arousal hypothesis serves as an alternative explanation for the Mozart effect, and pertains to contexts in which music listening occurs prior to task performance (Thompson et al., 2001). Schellenberg and colleagues have since documented mood-arousal effects with different types of musical and nonmusical auditory stimuli, and with various cognitive tasks (Husain, Thompson, & Schellenberg, 2002; Schellenberg, 2005; Schellenberg & Hallam, 2005; Schellenberg et al., 2007).

A second body of research pertains to the ISE (see Jones, 1999, for a review), in which auditory stimuli (musical or otherwise) impairs task performance when two conditions are simultaneously present.[1] First, the task performer must rely on seriation (i.e., encoding and retrieving information in a particular order) to perform successfully, as is common in mental arithmetic, free recall, and serial recall tasks (Beaman & Jones, 1997; Perham, Banbury, & Jones, 2007). Second, the auditory stimuli must possess a high degree of acoustic variation, represented by the number of different sounds in the stimuli, as opposed to the number of sounds in general (Tremblay & Jones, 1998). Under these conditions, auditory distractions like music interfere with task-related items that are being held in working memory (Neath, 2000; Perham & Currie, 2014). Unlike the mood-arousal hypothesis, the ISE pertains to contexts in which music listening is concurrent with task performance. The ISE is robust, and can occur regardless of the modality of the task (auditory or visual; Campbell, Beaman, & Berry, 2002), the volume of the auditory stimuli (Ellermeier & Hellbruck, 1998; Tremblay & Jones, 1999), the listener's music preferences (Perham & Currie, 2014; Perham & Vizard, 2011), or the presence or absence of (perceivable or actual) speech from the auditory stimulus (Tremblay, Nicholls, Alford, & Jones, 2000; Perham, Hodgetts, & Banbury, 2013).

Research on the mood-arousal hypothesis and the ISE have expanded our understanding of the intricate relationship between music-listening and cognitive task performance. We acknowledge, however, that both of these effects apply to only a subset of contexts. Researchers have critiqued the mood-arousal hypothesis because it does not account for music-listening that is concurrent with task performance, which is generally more likely to occur in reality (Perham & Sykora, 2012). Conversely, the ISE pertains to music-listening that is concurrent with task performance, but applies primarily to tasks that involve seriation (Beaman & Jones, 1997). We thus sought to build upon this body of knowledge by integrating the literature on music and task performance with a social psychological theory that has broader application: social facilitation theory (Zajonc, 1965).

Social Facilitation Theory

Social facilitation refers to the phenomenon in which social presence—the presence of other people in the performance environment—interacts with task complexity to affect task performance (Zajonc, 1965, 1980). Specifically, research suggests that social presence facilitates simple task performance and hinders complex task performance, and that these effects strengthen as the salience of social presence increases (e.g., Baron, 1986; Bond, 1982; Bond & Titus, 1983; Cottrell, 1972; Guerin, 1993; Triplett, 1898). A simple task is conceptualized as a task that is typically easily learned, familiar, or repetitive, whereas a complex task is one that is difficult, novel, or has a high degree of variation, or is highly difficult (see Aiello & Douthitt, 2001, for a review). Researchers have uncovered several mediating mechanisms through which social presence affects task performance, such as physiological arousal or "drive" (Zajonc, 1965), evaluation apprehension (Cottrell, 1972), and, importantly, distraction (Baron, 1986).

Distraction-Conflict Theory

We used Baron's (1986) distraction-conflict theory of social facilitation as our theoretical framework in the current research. According to distraction-conflict theory, an individual needs to use relatively few attentional resources to perform well on simple or repetitive tasks, which can thus leave the individual understimulated and vulnerable to mind wandering (Levinson, Smallwood, & Davidson, 2012; Mason et al., 2007; Phillips, 2008; Teasdale et al., 1995). Conversely, an individual typically needs to allocate a large amount of attentional resources to perform well on complex or difficult tasks, which leaves few resources leftover to attend to anything aside from the task at hand (Baddeley & Hitch, 1974). The addition of social presence in the performance environment is considered a type of distraction that competes with the task at hand for attentional resources.

Citing the work of Kahneman (1973), Baron argued that distractions like social presence can evoke attentional conflict in one of two ways. The first, termed *structural interference*, occurs when the distraction requires the same neural or physiological mechanisms as the task. The second, termed *capacity interference*, occurs when a task requires a significant enough amount of attentional

[1] We are grateful to an anonymous reviewer for bringing our attention to this body of literature.

resources that it is difficult to adequately attend to anything beyond the task or to divide one's attention between the task and a distractor. Lastly, Baron (1986) posited that attentional conflict from either type of interference subsequently elicit "drive"—a state of heightened stress or physiological arousal—during task performance. Thus, task performance is not only affected by attentional conflict in distraction-conflict theory, but also by arousal.

During a simple task, which typically requires little attention to perform well, distractions should facilitate performance because (a) the distraction causes a narrowing of attention that allows the performer to block out irrelevant task cues (O'Malley & Poplawsky, 1971), and (b) the arousal that follows from the attentional conflict keeps the performer from mind-wandering or becoming bored. During a complex task, which typically requires much of one's attention to perform well, distractions should impair performance because the performer does not have the capacity to divide their attention between the task and the distraction. Furthermore, complex tasks are posited to be sufficiently stimulating on their own, and so attentional conflict causes the performer to be overly stimulated. In sum, distractions elicit attentional conflict and heightened arousal, which can be helpful during simple tasks and harmful during complex tasks.

Music Within the Distraction-Conflict Framework

By focusing on attention, distraction-conflict theory broadened the scope of social facilitation research by acknowledging that nonsocial distractions can affect task performance similar to social presence (Aiello & Howansky, 2015; Baron, 1986; Feinberg & Aiello, 2006; Sanders & Baron, 1975). Indeed, research on distraction-conflict theory suggests that social facilitation effects can occur with nonsocial distractions such as competing tasks (Baron, Moore, & Sanders, 1978; Feinberg & Aiello, 2006), and, importantly, with auditory distractions (O'Malley & Poplawsky, 1971).

In the current research, we conceptualized music as type of distraction, or an aspect of the performance environment that interferes with one's attention to a focal task (Jett & George, 2003). Indeed, evidence from several research studies suggest that music can distract listeners (e.g., Dibben & Williamson, 2007; Furnham & Strbac, 2002; Kwekkeboom, 2003; Schwebel et al., 2012). Treating music as a form of distraction also allowed us to draw from theory and research on distraction-conflict and social facilitation to understand how music might affect task performance.[2]

We believe that distraction-conflict theory not only allows us to conceptualize music as a distraction, but also allows us to organize the literature regarding music and task performance. First, Baron's (1986) proposition regarding structural interference is in line with research on the ISE, in which the task performer is holding task-related items in his or her working memory, and the identity of these items becomes confused with irrelevant sound items (e.g., Neath, 2000; Perham, Marsh, Clarkson, Lawrence, & Sörqvist, 2016). Second, distraction-conflict theory includes the proposition that distractions can affect performance not only through attentional conflict, but also through drive. This proposition allows for integration of findings from the mood-arousal hypothesis, according to which music improves task performance by affecting the performer's mood and arousal levels. Indeed, several research studies suggest that arousal is one mechanism by which music and other auditory distractions affect task performance (e.g., Furnham & Allass, 1999; Furnham & Bradley, 1997; Schellenberg et al., 2007; Thompson et al., 2001).

According to distraction-conflict theory, music should facilitate simple task performance by occupying some of the performer's abundant leftover attentional resources, and hinder complex task performance by demanding more attentional resources than the task performer has available (Aiello & Howansky, 2015; Aiello & Kolb, 1995; Baron, 1986; Baron et al., 1978; Feinberg & Aiello, 2006; Speier, Vessey, & Valacich, 2003). In other words, music should draw some of the task performer's attention away from the focal task, which can be beneficial during simple tasks by preventing boredom and mind-wandering, and can be harmful during complex tasks because the performer needs to allocate most of their attention to the task to perform well. Likewise, the attentional conflict caused by music should elicit higher levels of stress or arousal in the performer, thus improving performance on simple or repetitive tasks by keeping the performer adequately stimulated, and impairing performance on complex tasks by overstimulating the performer, given that complex tasks are sufficiently stimulating by themselves (Baron, 1986). We thus hypothesize that listening to music will improve simple task performance and hinder complex task performance.[3]

> *Hypothesis 1:* Music, regardless of complexity and volume, will cause higher levels of simple task performance (1a) and cause lower levels of complex task performance (1b), relative to no music.

In line with the broader social facilitation theory, research suggests that the effects of distractions on task performance should strengthen as the distraction's salience increases because the distraction would (a) consume more leftover cognitive resources during simple tasks, or (b) cause even greater attentional conflict during complex tasks (e.g., Aiello & Stein, 2012; Baron, 1986; Furnham & Allass, 1999; O'Malley & Poplawsky, 1971).

We manipulated music salience in two ways. First, we manipulated the volume of the music (50–56 dB vs. 62–78dB). Research suggests that loud volumes can elicit social facilitation effects and cause a narrowing of attention, as posited in distraction-conflict

[2] Music has many components that can affect task performance in numerous and sometimes competing ways, such as through its lyrical content (Perham & Currie, 2014), its enjoyability (Schellenberg & Hallam, 2005), and its tempo and mode (i.e., major or minor; Husain et al., 2002; Thompson et al., 2001). As we will discuss, we held many of these factors constant in the current research by using the same musical piece and varying (a) the number of musical layers that were present and (b) the volume of the music. Using the same musical piece allows us to rule out many of these factors as potential confounds.

[3] As we will discuss in the method section, we operationalized the simple task as a simple vigilance task and the complex task as a difficult word pair associations task. However, we chose to hypothesize broadly about simple and complex tasks, rather than focusing on the specific type of cognitive ability assessed by each task, in line with the social facilitation literature (e.g., Aiello & Douthitt, 2001). Much of the social facilitation research maintains a broad focus on simple and complex tasks, which have been operationalized through various tasks. Therefore, we felt it was appropriate to restrict our focus on tasks to this broad level of conceptualization.

theory (O'Malley & Poplawsky, 1971); thus, we felt it was a suitable manipulation in the current study. Second, we manipulated music complexity, operationalized as the number of instrumental layers in the music piece (i.e., the same music piece with or without a percussion and bass track). Greater levels of cognitive processing should be required for music possessing more musical layers (e.g., Dillman Carpentier, 2010), thus potentially causing greater attentional conflict with the task at hand. Past research examining music and distraction has also used the number of musical layers in operationalizations of music complexity, and thus, we felt it was a suitable operationalization for the current study (Dillman Carpentier, 2010; Furnham & Allass, 1999).[4]

> *Hypothesis 2:* Higher levels of music volume will cause higher levels of simple task performance (2a) and cause lower levels of complex task performance (2b).

> *Hypothesis 3:* Higher levels of music complexity will cause higher levels of simple task performance (3a) and cause lower levels of complex task performance (3b).

Individual Differences: Preference for External Stimulation

Like other social facilitation theories, distraction-conflict theory does not explicitly address individual differences (Aiello & Douthitt, 2001). This is particularly surprising, given evidence that personality factors moderate social facilitation effects (for a meta-analysis, see Uziel, 2007). For example, Aiello and Svec (1993) found that an *external* locus of control (i.e., the belief that outcomes are caused by external factors beyond one's control) positively predicts anxiety when one's task performance is electronically monitored, whereas an *internal* locus of control (i.e., the belief that outcomes are caused by internal factors within one's control) positively predicts anxiety when there is no monitoring. As another example, Uziel (2007) found that social presence improves performance for individuals with high levels of extraversion and self-esteem, and impairs performance for individuals with high levels of neuroticism and low levels of self-esteem. Given this evidence, we believe that individual differences can provide meaningful information regarding the boundary conditions of social (and in our case, "nonsocial") facilitation effects.

Personality has received some attention in the music and task performance literature. Such research has typically focused on the moderating effects of extraversion, which is a broad personality trait associated with factors such as sociability, gregariousness, and positive affectivity (Costa & McRae, 1992). Relative to introverts, extraverts tend to have lower resting cortical activity levels (Eysenck, 1967) and thus are more likely to benefit from the stimulation music provides while they are performing tasks (Furnham & Allass, 1999; Furnham & Bradley, 1997; Lieberman, 2000). Indeed, evidence from several experimental studies suggests that the presence of music leads to improved task performance among extraverts, and impaired task performance among introverts (Daoussis & McKelvie, 1986; Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Strbac, 2002).

Aside from extraversion, personality traits have received limited attention in the literature on music and task performance. While we acknowledge the contributions of the research on extraversion cited above, we expect that there are additional personality factors that are relevant to the music—task performance context. Furthermore, there are recent calls by personality researchers to study narrow personality traits (e.g., Hough, Oswald, & Ock, 2015; Oswald & Hough, 2011), citing that narrow traits may allow for better theoretical matching between personality and performance in specific contexts. Likewise, we believe that focusing on narrow personality traits would allow for a fine-grained analysis of the ways in which music may affect task performance.

In the current research, we examined the preference for external stimulation—which is a dimension of boredom proneness—as a relevant individual difference. Boredom proneness refers to one's relatively stable propensity to become bored (Farmer & Sundberg, 1986). Researchers have identified an external stimulation dimension of boredom proneness (Vodanovich & Kass, 1990; Vodanovich, Wallace, & Kass, 2005), in which people generally perceive low stimulation from their environments. Boredom proneness researchers have contrasted the external stimulation dimension of boredom proneness (henceforth referred to as the "preference for external stimulation") with an internal stimulation dimension, reflecting the extent to which people are able to regulate their boredom internally by keeping themselves entertained.[5]

Distractions like music may be especially appealing to individuals with a strong preference for external stimulation, given their propensity to attend to stimulating elements of their environment (Seib & Vodanovich, 1998; Vodanovich & Kass, 1990). Research has linked stronger preferences for external stimulation with a tendency to seek out stimulation by engaging more with their external environment, such as by engaging in deviant behaviors at work (Bruursema, Kessler, & Spector, 2011), and a tendency to attend to stimulating aspects of one's environment (Seib & Vodanovich, 1998; Vodanovich & Kass, 1990). Specifically, while we hypothesized that listening to music will cause attentional conflict with the focal task, we would argue that this attentional conflict will be greater for individuals with strong preferences for external stimulation because they should mentally engage with the music more. Music may thus occupy even more attentional resources for people with stronger preferences for external stimulation. Aiello and Svec (1993) made similar arguments about individual differences in social facilitation effects, suggesting that social presence may be more salient, and thus have stronger effects, to individuals who tend to focus outward to the environment. While the authors applied this logic to individual differences in locus of control, we believe that it also applies to preferences for external stimulation.

Music, Complex Task Performance, and Preference for External Stimulation

We hypothesized earlier that music (and especially salient music) would impair complex task performance by causing greater

[4] Specifically, Furnham and Allass (1999) treated the number of instrumental layers as one of several dimensions of musical complexity, in addition to other factors such as tempo and repetition.

[5] Boredom proneness researchers have named this dimension "external stimulation." However, we chose to refer to it instead as the "preference for external stimulation" to make it clear that this is an individual difference variable and to prevent confusion with the music independent variables, which are objective sources of external stimulation.

attentional conflict with the task, which already requires a large degree of attention to perform well. It follows from this logic that complex task performance should decline more for individuals who pay greater attention to the music. We suggest here that individuals with stronger preferences for external stimulation—who are more likely to seek out sources of stimulation from their environment (Seib & Vodanovich, 1998; Vodanovich & Kass, 1990) – will pay greater attention to music while they are performing tasks, which can be harmful when the task is complex. In other words, we do not suggest that task performers with strong preferences for external stimulation would engage in the task less, but instead propose that they would engage in the music more. Therefore, we hypothesize that stronger preferences for external stimulation should negatively predict complex task performance when music is present, relative to when music is not present. Furthermore, stronger preferences for external stimulation should more negatively predict complex task performance as music salience (i.e., music complexity and volume) increases, given that the music should have an even greater attentional pull as its salience increases.

> *Hypothesis 4a:* Music presence (regardless of complexity or volume) will moderate the relationship between one's preference for external stimulation and complex task performance. Specifically, preference for external stimulation will negatively predict complex task performance when there is music, relative to no music.

> *Hypotheses 4b and 4c:* Music complexity and volume will moderate the relationship between one's preference for external stimulation and complex task performance. Specifically, preference for external stimulation will more negatively predict complex task performance as music complexity increases (4b) and as volume increases (4c).

Music, Simple Task Performance, and Preference for External Stimulation

Regarding simple tasks, it is unclear how music and music salience will affect the relationship between preference for external stimulation and task performance. As discussed earlier, we suspect that people with stronger preferences for external stimulation will pay greater attention to music (and especially salient music). On the one hand, this may make people with stronger preferences for external stimulation even less susceptible to boredom, which could keep them on-task and further prevent mind-wandering. On the other hand, music—especially highly salient music—could become too distracting for individuals with stronger preferences for external stimulation, making it difficult to even focus on simple tasks. Such a curvilinear effect has also been offered in the broader social facilitation theory (Zajonc, 1965), according to which too much physiological arousal from social presence could eventually impair simple task performance. We therefore did not offer hypotheses regarding how music affects the relationship between preferences for external stimulation and simple task performance. Instead, we asked the following exploratory research question:

> *Research Question 1:* How will music (regardless of music complexity or volume; 1a), music complexity (1b), and music volume (1c) moderate the relationship between preference for external stimulation and simple task performance?

Method

We examined our hypotheses with a 2 (Music Complexity: simple, complex) × 2 (Volume: low, high) + 1 (Control: no music) between-subjects experimental design. Participants in the control condition were not exposed to the music complexity and volume manipulations, given that music was not played for these individuals.[6] We recruited 150 undergraduate students (74.67% female, 42.67% Caucasian, age $M = 21.23$ years [$SD = 3.42$]) from various psychology courses who participated for course credit. We excluded eight participants' simple task data and six participants' complex task data either due to technical issues or because they were performance outliers (i.e., greater than 1.5 times the interquartile range above or below the mean, which is the default option for SPSS; Field, 2013).[7] All study procedures and materials described below received approval from an Institutional Review Board prior to data collection. Data for the current study can be obtained from the first author upon request.

Materials and Stimuli

All questionnaire items described in this section had 7-point Likert scales (1 = *strongly disagree*, 7 = *strongly agree*).

Simple task. Participants completed a pencil-and-paper finding *A*s task, which involved searching through lists of words and crossing off as many words containing the letter *A* as they could (Ekstrom, French, Harman, & Derman, 1976). The task included a brief practice trial and two back-to-back 5-min sessions with different packets for each section. Participants received one point for every correct word they crossed out and lost one point for every incorrect word they crossed out and for every correct word they missed up until the point where they stopped in the packet (i.e., correct – [incorrect + miss]).

Complex task. Participants completed a computer-based, modified version of the word pair association task used by Spence, Farber, and McFann (1956); Cottrell (1972), and Baron et al. (1978). Participants studied lists of word pairs and were subsequently shown one word from each pair and asked to type the corresponding word. The task included one practice round of six word pairs, followed by two test rounds with 18 word pairs each. Word pairs were semantically related in the first test round (e.g., "tranquil-quiet"), and were semantic opposites in the second round (e.g., "hungry-satiate"). We used the same practice trial and se-

[6] Some of the research investigating music has also included "white noise" control conditions, in which non-musical sound is played to differentiate the effects of music from the effects of other forms of auditory distractions. While we did not include such a secondary control condition, we refer readers to other research showing that music can be just as (if not more) distracting white noise (Furnham & Strbac, 2002; Salame & Baddeley, 1989).

[7] Each time a set of outliers were identified and excluded, we reran the outlier analysis to identify any additional outliers in the reduced sample. We repeated this process until no other outliers were detected in the data.

mantically related round as the original version of the task.[8] To increase the task's difficulty, we altered the second test round—which originally involved the same set of words from the first test round, but paired differently—by creating new, semantically opposite word pairs. Participants received one point per correct answer across both test rounds.[9]

Music. A music student at the university created two original music pieces for the current study, which allowed us to manipulate music complexity. Both pieces were identical (i.e., same piano, strings, and synthesizer audio tracks), except that the complex music included additional drum and bass tracks. Both music pieces have been made publicly available on the Open Science Framework.[10] For the volume manipulation, the music volume ranged from 50–56 dB in the soft condition and from 62–78dB in the loud condition. Music was played on repeat during the finding *A*s and word pair tasks. The music was played through a set of speakers that were connected to a computer in an adjacent room.

In addition to music complexity and volume, we calculated a "music presence" variable by collapsing all participants who listened to music, regardless of its complexity or volume, into one category. Doing so allowed us to compare control participants who did not listen to music to participants in any of the music conditions.

Preference for external stimulation. Participants completed Farmer and Sundberg's (1986) 28-item Boredom Proneness Scale, eight items of which were used to calculate preference for external stimulation scores (sample item: "It takes a lot of change and variety to keep me really happy"; $\alpha = .75$).

Cognitive ability. Past research has shown that boredom is more likely when a task's difficulty falls extremely above or below one's ability level (Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010). Therefore, we measured and controlled for cognitive ability to more cleanly examine boredom proneness as an individual difference, without the potential contaminating effects of cognitive ability on our dependent variables. To do so, participants completed the 12-min, 50-item, multiple-choice style Wonderlic Personnel Test (Form IV; henceforth referred to as "Wonderlic"), which is a validated measure of general cognitive ability (Wonderlic, 1973). Participants received one point for every correct test answer. Music was not played during this task.

Task difficulty. After each task, participants received a questionnaire assessing various task perceptions. We created five items to assess perceived task difficulty (sample item: "How difficult do you feel this task was?"). Scores were acceptably reliable for each task (αs $\geq .72$).

Procedure

The current research was part of a larger study.[11,12] Participants completed the study individually in an office space. Participants first completed personality measures, including the Boredom Proneness Scale, followed by the Wonderlic. Participants next completed cognitive tasks, including the finding *A*s and word pair tasks, the order of which were counterbalanced. Each task was followed by a task perceptions questionnaire. To motivate participants, they were told prior to each task that the highest scorers would be entered into a gift card raffle. Depending on the experimental condition, participants listened to either simple or complex music at either a soft or loud volume during the finding *A*s and word pair tasks. Participants in the control condition did not listen to music, and thus were not exposed to the music complexity or volume manipulations. Music was not played outside of the tasks.

Results

Task Perceptions

One-sample *t* tests revealed that finding *A*s difficulty ratings fell significantly below the scale midpoint, $M = 3.38$, $t(149) = -8.23$, $p < .001$, whereas word pair difficulty ratings were significantly above the midpoint, $M = 5.25$, $t(149) = 14.66$, $p < .001$. A paired-samples *t* test also showed that the word pair task was rated significantly more difficult than the finding *A*s task, $t(145) = 17.32$, $p < .001$.

Hypothesis Tests

Descriptive statistics and correlations for key study variables are presented in Table 1. We analyzed the data using general linear modeling, which allowed us to model two-way and three-way interactions between preference for external stimulation scores (a continuous variable), music complexity and volume (nondichotomous categorical variables; Cohen & Cohen, 1983). Wonderlic scores were controlled in all analyses, and were a significant covariate in all cases, Fs ≥ 8.43, ps $\leq .004$.

Simple task performance. We first examined whether music presence (regardless of complexity and volume) affected finding *A*s scores. Contrary to Hypothesis 1a, finding *A*s scores did not significantly differ between the music presence condition, $M = 96.27$, and the no music condition, $M = 90.83$, $F(1, 135) = 1.48$, $p = .23$, $\eta^2_p = .01$, though the means were in the hypothesized

[8] Spence et al. (1956) referred to the semantically related trials as "noncompetitional" because the words in each pair were related to each other, but were not related to words in other pairs.

[9] The simple and complex tasks may each measure different cognitive abilities, which could bring into question the comparability of our task performance measures. However, we do not believe that this poses a major threat to the validity of the current research, given that social facilitation effects have been documented with a variety of tasks (for reviews, see Aiello & Douthitt, 2001; Seitchik, Brown, & Harkins, 2017).

[10] See https://osf.io/xs85u/?view_only=eecccb0df58d4243bd00885b5aacabef.

[11] In addition to the measures described here, participants completed a 20-item digit span task, the presentation order for which was counterbalanced with the finding *A*s and word pair tasks, and several exploratory personality measures, which were administered at the same time as the boredom proneness scale. The digit span demonstrated low variability in scores, which we interpret as a ceiling effect ($M = 16.47$, $SD = 2.36$, with 80% of the sample making five or fewer incorrect answers), and thus we chose not to discuss the task further within this article. The exploratory personality measures included (a) the 34-item Tellegen Absorption Scale (Tellegen & Atkinson, 1974) and (b) the 120-item version of the International Personality Item Pool version of the NEO Personality Inventory (Johnson, 2014), which measures each of the Big Five personality traits (i.e., extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience) along with their respective facets. NEO Personality Inventory dimension scores were computed online from the publishing author's website, and thus reliability statistics could not be generated. Data for these measures are available from the authors upon request.

[12] At the time of submitting this article for publication, data from the broader study has not been published elsewhere.

Table 1
Correlations and Descriptive Statistics for Study Variables

Study variables	*M* (*SD*)	1	2	3	4
1. Finding *A*s scores	93.28 (42.61)	—			
2. Word pair scores	14.74 (5.85)	.37***	—		
3. Wonderlic scores	23.69 (4.70)	.28***	.35***	—	
4. Preference for external stimulation	3.29 (1.00)	.10	.19*	.24**	(.75)

Note. Cronbach α reported in diagonal where applicable.
* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

direction (i.e., higher scores with music than without music). Preference for external stimulation did not significantly predict finding *A*s scores, $F(1, 135) = .01$, $p = .91$, $\eta_p^2 = .00$, nor did it interact with music presence to predict finding *A*s scores, $F(1, 135) = 1.10$, $p = .30$, $\eta_p^2 = .01$. Thus, regarding Research Question 1a, the presence of music (regardless of music complexity and volume) did not moderate the relationship between preference for external stimulation and simple task performance.

We next examined the effects of music complexity and volume on finding *A*s scores. First, supporting Hypothesis 2a, music complexity had a significant main effect, $F(1, 129) = 5.25$, $p = .02$, $\eta_p^2 = .04$, such that finding *A*s scores were highest when there was complex music, $M = 97.52$, relative to simple music, $M = 91.31$, and no music, $M = 91.00$. Contrary to Hypothesis 3a, volume did not have a significant main effect on finding *A*s scores, $F(1, 129) = 3.17$, $p = .08$, $\eta_p^2 = .02$, though the effect approached significance and the means were in the hypothesized direction (loud $M = 96.90$; soft $M = 91.93$; no music $M = 91.00$).

We found significant two-way interactions between preference for external stimulation and both music complexity, $F(1, 129) = 4.40$, $p <= .04$, $\eta_p^2 = .03$, and volume, $F(1, 129) = 4.33$, $p = .04$, $\eta_p^2 = .03$, on finding *A*s scores. Regarding the music complexity interaction, preference for external stimulation significantly and negatively predicted finding *A*s scores when there was complex music, $B = -12.01$, $SE = 4.64$, $p = .01$, but did not predict finding *A*s scores when there was simple music, $B = 7.44$, $SE = 4.40$, $p = .10$, or no music, $B = 5.91$, $SE = 8.33$, $p = .49$. From examining the interaction plot in Figure 1, relative to the other music complexity conditions, complex music yielded the highest finding *A*s scores when preference for external stimulation was low, and yielded the lowest finding *A*s scores when preference for external stimulation was high.

Regarding the volume interaction, preference for external stimulation significantly and negatively predicted finding *A*s scores when the volume was soft, $B = -11.94$, $SE = 4.35$, $p = .01$, but did not predict finding *A*s scores when the volume was loud, $B = 6.49$, $SE = 4.50$, $p = .16$, or when there was no music, $B = 5.91$, $SE = 8.33$, $p = .49$. From examining the interaction plot in Figure 2, relative to the other volume conditions, soft volume yielded the highest finding *A*s scores when preference for external stimulation was low and yielded the lowest finding *A*s scores when preference for external stimulation was high.

Thus, regarding Research Questions 1b and 1c, our data suggest that music salience moderates the relationship between preference for external stimulation and simple task performance. Specifically, depending on how music salience is operationalized, preference for external stimulation predicted poorer simple task performance when music was moderately salient (i.e., soft volume) or highly salient (i.e., complex music). We address these findings in the discussion section. No other significant main effects or interactions were found in our analysis of finding *A*s scores.

Complex task performance. We examined whether music presence (regardless of music complexity or volume) affected word pair scores. Supporting Hypothesis 1b, music presence had a significant main effect, $F(1, 136) = 5.84$, $p = .02$, $\eta_p^2 = .04$, such that participants had lower word pair scores when music was present ($M = 14.56$) than when there was no music ($M = 15.21$). Preference for external stimulation positively predicted word pair scores, $F(1, 136) = 7.42$, $p = .01$, $\eta_p^2 = .05$, and these two main effects were qualified by a significant interaction between music presence and preference for external stimulation, $F(1, 136) = 6.89$, $p = .01$, $\eta_p^2 = .05$.

Probing the interaction revealed that preference for external stimulation significantly and positively predicted word pair scores when there was no music, $B = 3.15$, $SE = .82$, $p = .001$, but did not predict scores when music was present, $B = .11$, $SE = .50$, $p = .82$. From examining the interaction plot in Figure 3, music (rel-

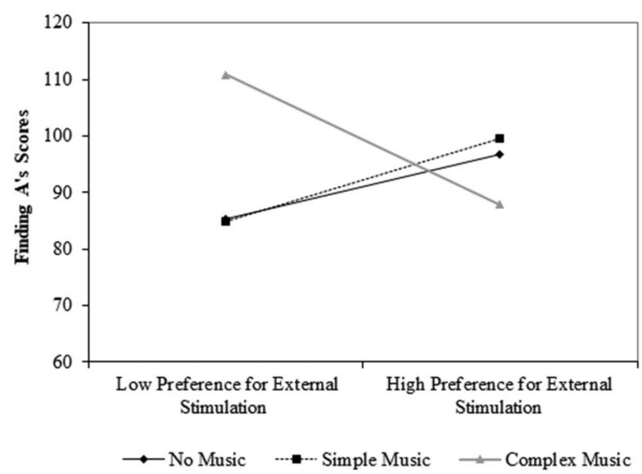

Figure 1. The interaction between the preference for external stimulation and music complexity on finding *A*s scores is presented. Preference for external stimulation significantly and negatively predicted finding *A*s scores in the complex music condition, $B = -12.01$, $SE = 4.64$, $p = .01$, but not in the simple music, $B = 7.44$, $SE = 4.40$, $p = .10$, and no music conditions, $B = 5.91$, $SE = 8.33$, $p = .49$. From examining the plot, complex music increased finding *A*s scores when preference for external stimulation was low, but did not facilitate performance when preference for external stimulation was high.

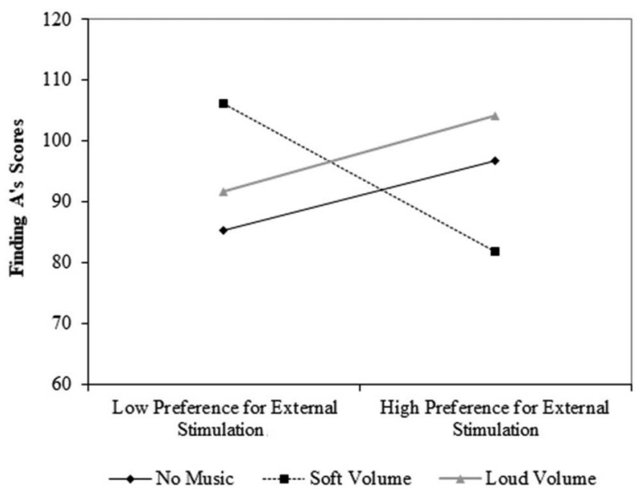

Figure 2. The interaction between the preference for external stimulation and music volume on finding *A*s scores is presented. Preference for external stimulation significantly and negatively predicted finding *A*s scores when the volume was soft, $B = -11.94$, $SE = 4.35$, $p = .01$ but did not predict scores in the simple music, $B = 6.49$, $SE = 4.50$, $p = .16$, and no music conditions, $B = 5.91$, $SE = 8.33$, $p = .49$. From examining the plot, individuals with low preferences for external stimulation performed best when there was soft volume, whereas individuals with high preferences for external stimulation performed worst when there was soft volume.

ative to no music) increased word pair scores when preference for external stimulation was low, but decreased scores when preference for external stimulation was high. While the interaction pattern was not what we hypothesized (i.e., a negative relationship between preference for external stimulation and complex task performance when music was present), we nevertheless found that music was more harmful for complex task performance when preference for external stimulation was high. Hypothesis 4a thus received partial support.

We next examined whether music complexity and volume affected word pair scores. However, no significant main effects or interactions were found for music complexity, volume, nor preference for external stimulation on word pair scores, Fs$(1, 130) \leq 1.04$, ps $\leq .31$, η_p^2s $\leq .01$, except for a main effect of preference for external stimulation, $F(1, 130) = 5.06$, $p = .03$, $\eta_p^2 = .04$. Hypotheses 2b, 3b, and 4b, and 4c were thus not supported.

Discussion

At the onset of this article, we offered an interactionist framework to examine the effects of music on task performance, considering both the unique and combined effects of music-based, task-based, and task performer-based characteristics. Our findings lend credence to such an investigative approach, and suggest that the effects of music on task performance depend on (a) the salience of the music (operationalized as the music's complexity and volume levels), (b) task complexity, and (c) individual differences in preferences for external stimulation—a dimension of boredom proneness. In doing so, our findings expand knowledge of the psychology of music (and more broadly, distractions), boredom proneness, and social facilitation. We highlight these different contributions throughout our discussion.

Does Music Affect Task Performance?

A key finding from our research is that music can facilitate simple task performance and hinder complex task performance, in line with distraction-conflict theory (Baron, 1986). First, we found that music (i.e., regardless of its complexity or volume) hindered complex task performance, relative to no music. Complex tasks like the word pair task require more of the task performer's attention to perform well (Baddeley & Hitch, 1974), and so music may have hindered word pair performance by causing attentional conflict with the task.

Second, we found that the salience of the music, rather than music presence, influenced simple task performance. Highly salient distractions consume more attentional resources than less salient distractions (O'Malley & Poplawsky, 1971). Because simple tasks tend to underutilize the performer's attentional resources (Levinson et al., 2012), salient distractions—such as complex or loud music in the current study—more strongly facilitate simple task performance by occupying more leftover attentional resources and reducing the likelihood of mind-wandering. Additionally, salient distractions can cause a narrowing of attention, allowing the task performer to block out irrelevant task cues (Baron, 1986). In the case of the finding *A*s, this narrowing of attention can help with blocking out irrelevant stimuli (i.e., words without the letter *A*), thus reducing errors and increasing performance. Indeed, complex music led to the highest levels of simple task performance in the current research, relative to simple music or no music. We also found a similar pattern in which loud volumes increased simple task performance, relative to soft volumes or no music, though the pattern fell just below the threshold for statistical significance. Our

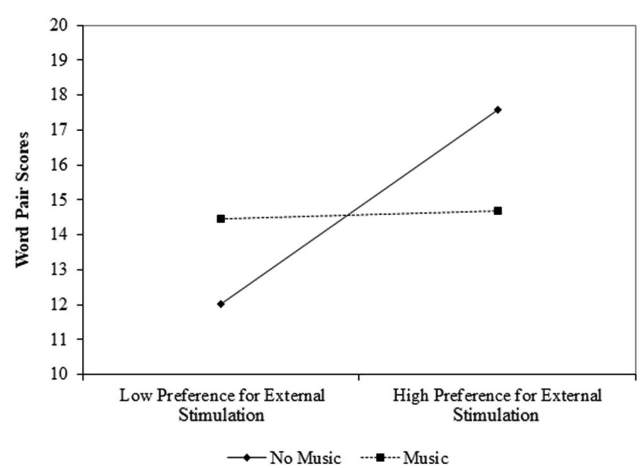

Figure 3. The interaction between music presence and the preference for external stimulation on word pair scores is presented. Preference for external stimulation significantly and positively predicted word pair scores when there was no music, $B = 3.15$, $SE = .82$, $p < .001$, but did not predict performance when there was music, $B = .11$, $SE = .50$, $p = .82$. From examining the plot, music presence facilitated performance when preference for external stimulation was low, but hindered performance when preference for external stimulation was high.

findings are thus in line with that of other researchers who have shown that auditory distractions can facilitate task performance in some cases (e.g., Furnham & Allass, 1999; O'Malley & Poplawsky, 1971). Overall, our findings challenge the conventional belief that distractions are always detrimental to task performance (for a similar argument, see Jett & George, 2003).

Contrary to our hypotheses, music salience (i.e., music complexity and volume) did not affect complex task performance. This finding runs contrary to distraction-conflict theory, according to which complex task performance should decline more as distractor salience increases. It is possible that while the word pair task was complex enough to detect a general effect of music on performance (regardless of music complexity or volume), the task may not have been complex enough to find effects of distraction salience. Another explanation comes from research on the ISE. Research in this area has shown that volume does not influence the extent to which auditory distractions impair performance on tasks that involve recall (Ellermeier & Hellbruck, 1998). Specifically, ISE researchers would posit that acoustical variation, rather than volume, causes music to impair performance on these types of tasks. However, the lack of an effect for music complexity is difficult to explain from this perspective, given that the addition of a drum and bass track to the music piece should also introduce greater acoustic variation, and thus cause greater disruption. Future research may thus benefit from further exploring both (a) the degree of task complexity and (b) the task type (e.g., serial recall, vigilance) as a moderator of music's effects on task performance.

Music and Preference for External Stimulation

Complex task performance. We found that music affected task performance differently depending on individual differences in the preference for external stimulation. We hypothesized that preference for external stimulation, which involves a greater tendency to seek out and attend to stimulating aspects of one's environment (e.g., Bruursema et al., 2011; Seib & Vodanovich, 1998; Vodanovich & Kass, 1990; Vodanovich et al., 2005), would negatively predict complex task performance when there was music, and more so when the music was highly salient (i.e., complex or loud). Our data offered mixed support for these hypotheses. Relative to no music, music generally hindered complex task performance when preference for external stimulation was high. However, we found that preference for external stimulation positively predicted complex task performance when there was no music, and did not predict complex task performance when there was music.

We interpret the above finding as follows: complex tasks like the word pair task can serve as sufficient stimulation from one's work environment. This is in line with a tenet of distraction-conflict theory (Baron, 1986) according to which complex tasks can be sufficiently stimulating on their own. Preference for external stimulation may thus predict more attention given to complex tasks, and hence better performance on these tasks. This interpretation would explain why music hindered complex task performance for people with higher preferences for external stimulation, and why preferences for external stimulation positively predicted complex task performance when there was no music. Further supporting our interpretation, we found that preference for external stimulation positively predicted performance on both the cognitive ability test and the word pair task, both of which are complex tasks. Based on these results, stronger preferences for external stimulation may be associated with greater levels of engagement in complex tasks, which is somewhat ironic, given that the preference for external stimulation is a dimension of boredom proneness. Our findings thus offer a potentially exciting new avenue for boredom proneness research.

It is unclear, however, why music would improve complex task performance when preferences for external stimulation are low, as can be seen in Figure 3. One possibility is that while the word pair task was complex, it was not complex enough for music to impair individuals with weaker preferences for external stimulation. This would align with our explanation for why music salience did not exacerbate the effects of music on word pair performance. Another possibility is that there are additional mediators by which music can improve complex task performance that distraction-conflict theory does not account for. We are currently unable to offer a definitive explanation for this finding, and so we offer it as a direction for future research.

Simple task performance. We found that complex music and soft volumes facilitated simple task performance when preference for external stimulation was low and hindered simple task performance when preference for external stimulation was high. Thus, the effects of music salience on simple task performance seem to depend on (a) how music salience is operationalized, and (b) the extent to which people attend to environmental distractions such as music (i.e., preference for external stimulation).

While we are uncertain of how to interpret the finding for music volume, the music complexity finding makes sense from a distraction-conflict perspective. As a form of social facilitation theory, distraction-conflict theory maintains that the salience of a distraction may have a curvilinear effect on performance (Baron, 1986). While distractions may facilitate simple task performance to a degree, there is also a point at which distractions will overload task performers even during simple tasks. Turning to Figure 1, we see that complex music (i.e., a salient distraction) improved simple task performance when preference for external stimulation was low, in which case one is less likely to pay a high degree of attention to the music. However, this effect was attenuated when preference for external stimulation is high, in which case one is prone to attend more to the music, and thus may be more distracted when the music is highly salient.

It is also possible that aside from attentional conflict, complexity and/or volume might affect simple task performance through additional mediating mechanisms. As distraction-conflict theory posits, distractions can influence performance through both attention and arousal. It is therefore possible that music complexity and volume had differential effects on simple task performance through these different mediating mechanisms. For example, Van der Zwaag, Westerink, and Van der Broek (2011) found that percussive music influenced emotional reactions and physiological arousal in participants. Percussion was one music element that differentiated the simple and complex music in our research, and so future research should examine whether additional emotional and physiological mechanisms mediate any of the effects that we found. Doing so would also allow for a better integration of findings across music studies.

Theoretical Implications

Our research has several theoretical implications. First, we hope that our findings encourage researchers to adopt a more holistic, interactionist approach to investigate the effects of music (and, more broadly, distractions) on task performance. As we suggested at the onset of the article, understanding how music affects task performance likely depends on (a) what one is listening to (i.e., music characteristics), (b) what task is being performed (i.e., task characteristics), and (c) who is listening to the music (i.e., task performer characteristics). Given the history of mixed findings on this topic (Kampfe et al., 2010), an interactionist approach would allow for a nuanced and systematic investigation of how, when, and for whom music can influence task performance. Furthermore, such an approach would allow researchers to connect the literature on the psychology of music to other areas of psychology. Using the current research as an example, here we drew upon—and in turn contributed to—theory and research in music psychology (i.e., music and task performance), cognitive psychology (i.e., attention and distraction), personality psychology (i.e., boredom proneness), and social psychology (i.e., social facilitation) to investigate our research questions.

Second, we offered and tested several individual and situational conditions in which distractions like music can help or hinder task performance. However, we note that researchers should attempt to replicate these effects in other settings. Third, we contribute to research on boredom proneness by illustrating conditions in which boredom proneness (specifically, the preference for external stimulation) can predict constructive outcomes, such as better complex task performance. Given that boredom is a socially devalued emotion (Darden & Marks, 1999), we hope that the findings of the current researchers will motivate researchers to adopt a more balanced approach to examining both constructive and destructive aspects of boredom proneness.

Lastly, like the early work of Baron and colleagues (Baron, 1986; Sanders & Baron, 1975), we found that the effects of social facilitation can extend to nonsocial domains, which in this case was the presence or absence of music. We echo these researchers' callings to consider how nonsocial factors, including other types of distractions, can affect task performance similar to social presence. For example, researchers can examine how increasingly common electronic distractions such as text messages, e-mail notifications, and electronic performance monitoring (e.g., Aiello & Douthitt, 2001; Alge & Hansen, 2014; Fox, Rosen, & Crawford, 2009) can potentially spill over into task performance.

Practical Implications

Our research has practical implications that we feel are particularly relevant for educational and organizational contexts where people commonly perform cognitive tasks. First, we offer evidence against the commonly held belief that distractions like music will always harm task performance (e.g., Breuer, 1995; Roper & Juneja, 2008). Instead, we offer a nuanced view of distractions, such that they can either help or hinder performance, depending on the performer and the context. Educators and managers alike may consider a wider variety of factors (e.g., nature of the work, salience of the distraction) when determining whether distractions such as music can benefit or impair their students' and employees' performance on tasks, respectively.

Second, our findings suggest that the relationship between music and task performance is not "one-size-fits-all." In other words, music does not appear to impair or benefit performance equally for everyone. By examining the preference for external stimulation, our data illustrate cases in which music can improve performance for some people and impair performance for other people within the same context. As such, organizations that either currently incorporate music or plan to incorporate music into the work environment may consider ways for employees to selectively expose themselves to music. For example, offering mediums such as headphones to employees would allow them to listen to music if they feel that they need it, but it would also allow other employees to opt out of listening to music if they feel they would be too distracted by it. Additionally, managers and educators alike may consider teaching effective strategies by which employees and students can cope with distractions while they work.

Finally, our findings suggest that boredom proneness can have beneficial aspects to it. We refer specifically to the positive relationship we found between the preference for external stimulation and complex task performance, particularly when there was no music. Our findings thus suggest that people can sometimes use stimulating tasks to regulate their boredom. Educators and organizational practitioners alike may thus consider developing interventions to help students and employees regulate their boredom in constructive ways. For example, managers might design tasks to provide a greater sense of challenge for their employees, though doing so may also require employees to appraise their tasks as a challenge, rather than as a threat.

Limitations and Future Research

Our research also has its limitations. First, we examined task performance over a short time period, making it unclear whether our results would generalize to task performance over longer time intervals. Task performers could eventually habituate to music over time. Additionally, people may get fatigued quicker if the music and the task have heavy attentional demands (i.e., a complex task and highly salient music), causing task performance to decline over time. Future research should thus investigate how music effects task performance over longer time periods.

Second, despite the central role of attention in our theoretical model, we did not directly examine distraction as a mediator of the effects of music on task performance. Additionally, given that distraction and arousal are closely intertwined in the distraction-conflict theory framework (Baron, 1986), our findings would have been strengthened if we had examined whether either or both of these mechanisms were at work in the current study. Future research may benefit from incorporating advanced neuro-physiological research technologies, such as eye tracking devices or electroencephalography, to examine levels of distraction and arousal in situ while people listen to music and perform tasks. Doing so would allow for a stronger case to be made for causality. We do offer a note of caution, however, as such technology could also introduce a confound from a social facilitation lens. Research suggests that social facilitation effects can be elicited through evaluation apprehension, in which participants feel a high degree of arousal from the fear of being evaluated by an audience or an experimenter (Cottrell, 1972).

We would imagine that technology such as eye trackers and electroencephalography could elicit evaluation apprehension across all experimental conditions, thus obscuring any possible social facilitation effects. Thus, while a more direct way to examine attention allocation during tasks would be an ideal way to replicate our findings in future research, we also offer a methodological word of caution in this regard.

Third, qualitative differences between the two tasks aside from their complexity levels could serve as an alternative explanation for our findings. In other words, one could argue that the music manipulations affected each task differently because the finding *A*s task measured vigilance and the word pair task measured recall or working memory. We chose to use two qualitatively different tasks in the current research to avoid the possibility of practice effects obscuring our findings. For example, participants could have had an easier time performing a complex word pair task if they completed a simple word pair task immediately beforehand, and vice versa. Additionally, researchers have documented social facilitation effects with word pair tasks (e.g., Feinberg & Aiello, 2006) and vigilance tasks (e.g., Harkins, 1987), and so we felt that these two types of tasks were appropriate to include in the current research. We recognize that these qualitative differences in task type could nevertheless influence the internal validity of our research and we acknowledge it as a limitation. Future research should thus further disentangle whether the task type serves as a boundary condition for social facilitation effects.

Fourth, one could posit that the finding *A*s and word pair tasks were not truly simple or complex, respectively. In other words, the finding *A*s task could have been made even simpler, and the word pair task could have been even more complex. However, we adapted the word pair task for this very reason by creating more difficult word pair associations for part of the task. We also needed to maintain a delicate balance so as to not design the tasks to be excessively easy or complex, otherwise there would have been a risk of ceiling and/or floor effects that could obscure our findings. The data also suggest that (a) the finding *A*s task was perceived as having a below average difficulty level, (b) the word pair task was perceived as having an above average difficulty level, and (c) the word pair task was perceived as significantly more difficult than the finding *A*s task. The data thus support the use of the finding *A*s as a simple task and the word pair as a complex task. While this is admittedly a subjective measure of difficulty, we feel that it is nevertheless important to show that participants generally experienced the tasks as being different in their difficulty levels. We acknowledge, however, that participants' perceptions can often be detached from the situation's objective reality (Bargh & Chartrand, 1999), and so future research should attempt to replicate our findings with more objective manipulations of task difficulty.

Lastly, we used novel, instrumental music in the current research. This allowed for greater experimental control by eliminating unwanted variance from music familiarity and differences between the music pieces. Additionally, using instrumental music helped us rule out the effects of lyrics, which could have caused verbal competition with the tasks or primed participants via the lyrical content. Despite the advantages of our experimental stimuli, we recognize that people commonly listen to music that they are familiar with and that a lot of popular modern music includes lyrics. We thus hope that our research will serve as a starting point for a more systematic investigation of music. In doing so, we hope to better understand the psychological effects of music.

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