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## **The effect of background music on the cognitive performance of musicians.**

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### Abstract

This study aimed to investigate how background music with different instruments affects musicians' performance on cognitive tasks. Participants completed three sets of cognitively demanding intelligence tasks in a Latin Square design where each group listened to a different piece of music, involving their own and other musical instruments. The results showed that musicians' performance on cognitive tasks is more impaired when listening to music featuring their own respective instruments than when not. These results are congruent with previous research and the central experimental hypothesis. Implications and limitations are noted.

## Introduction

There is now a considerable body of research, going back over 50 years, investigating the degree to which background music affects performance on cognitive tasks (Kirkpatrick, 1943). Most, but not all, of the empirical evidence suggests that the effect is detrimental, though the power of the distraction is a function of the music itself, the task being completed and the personality of the individual doing it (Kampfe, Sedlmeier & Renkewitz, 2010; Konecni, 1982, Ransdell & Gilroy, 2001).

Many studies have examined the interaction between personality (especially extraversion) and the distracting effect of background sound – including music (Dobbs, McClelland & Furnham, 2011; Furnham & Allas, 1999; Furnham & Strabc, 2002) as well as neuroticism (Reynolds, McClelland & Furnham, 2014). These studies have usually shown, as predicted, that Introverts and Neurotics tend to be more negatively affected by distraction than Stable Extraverts.

Research in this area is informed by different theoretical models. Many studies stress the relevance of arousal both in the nature of the music but also the personality of the listener (Mikkutta, Maissen, Altorfer, Strik & Koenig, 2014; Thompson, Schellenberg, & Letnic, 2012). Others have focused on factor such as the familiarity of the distracting stimuli as well as the task that is being completed (Buchweitz, Mason, Meschyan, Keller & Just, 2014).

Kiger (1989) proposed a categorization of music in terms of stimulation and suggested that soft, slow and repetitive music (with low information load) optimisers conditions for arousal. Music with low information load led to better performance on a reading comprehension task than silence, but music with high information load impaired performance. However, Furnham and Allas (1999) failed to replicate this effect. Banbury and Berry (1998) reported that background noise detrimentally affected performance on a mental arithmetic task, but did not adversely affect performance on a task requiring memory for prose.

Cassidy and MacDonald (2007) required participants to complete five cognitive tasks under four different conditions. They showed that performance was adversely affected across all the tasks when the participants were in the presence of background noise (including music) than when the tasks were conducted in silence. Tze and Chou (2014) developed an “Attention Drainage Theory” based on their finding that more high intensity music (hip hop) is more distracting and has a greater negative impact on task performance and concentration.

Overall the theories suggest that fast, familiar, loud, vocal music is most distractive, particularly on complex verbal tasks. They also suggest that introverts are more distracted than extraverts, and neurotics more distracted by stable people particularly when the task is personally threatening. It is also the case that the depth of processing involved in the task (i.e. trying to memorise material) is directly related to distraction in the sense that the more cognitively demanding the task, the more it is negatively prone to distraction interference.

The current study focuses on the interaction between the listener and the music focussing on musicians. Here, musicians are defined as those who have played a particular instrument for a few years and also play at least one hour per week. It aims to investigate the distracting effects of different types of background music when the music prominently features the musician's chosen instrument. Various studies have suggested that professional musicians listen to music differently than amateur musicians and are differentially distracted compared to non-musicians. Patston and Tippett (2011) had musicians and non-musicians complete both a language comprehension task and a visuo-spatial task in the presence of background music or in silence. The musicians showed poorer performance on the language comprehension task in the presence of music compared to silence, but no such effect was found for the visuo-spatial task. Non-musicians were unaffected by music on either task.

Few, if any, distraction type studies have compared the distraction effect between musicians. We suggest that the performance by a musician on a cognitive task will be more severely impaired in the presence of music that features *their chosen instrument* than in the presence of music featuring another instrument. It is assumed that particular instrument players would listen more carefully to music if it featured particularly their instrument and would therefore be more distracted leading to poorer performance on a cognitive task

A Latin-square design was employed in this study, with the participants (guitarists, pianists, and a control group of non-musicians) performing three cognitive tasks; one task in the presence of guitar music, one in the presence of piano music and one in the presence of saxophone music (see Table 1). Thus each group performed the same tests but with a different mapping of music conditions to tests.

Insert Table 1 here

## **Method**

### **Participants**

This study involved 60 participants in total, 29 of whom were male, and all were fluent English speakers. The mean age of the sample was 20.62 years ( $SD = 4.56$  years). Twenty of the participants were classified as guitarists, 20 as pianists and 20 non-musicians. In order to qualify for the study, guitarist and pianist participants were required to have played their respective instruments for a minimum of two years, and to play those instruments for at least an hour a week. We did not collect data on the amount of training that they had had however they did not differ from each other in terms of age or education level.

## **Materials**

This study utilized three pieces of music in the jazz genre. Each musical piece was an instrumental solo in order to eliminate the potential confounding effects of lyrical content and the presence of other instruments. These pieces chosen were a guitar solo (“Autumn In New York” performed by Peter Bernstein), a piano solo (“The Rainbow” performed by Ketil Bjørnstad), and a saxophone solo piece (“Finesse” performed by John Klemmer). All three pieces are played freely (i.e., without a rigid time signature), and each lasted four minutes, and were matched for volume (using Logic Pro software running on an Apple Mac computer). These pieces were then played to 10 musicians (who did not take part in the main study) who rated them for arousal, distractibility, mood and timbre on 10-point scales. No significant differences were found on any of the dimensions (all  $F_s < 1$ ).

The three cognitive tasks employed in the study were; an Arithmetic test, a Sentence Checking test, and the Wonderlic Personnel Test. These tests have been successfully used in a research programme investigating the distracting effects of music on cognitive performance (Furnham & Allas, 1999; Furnham & Bradley, 1997; Furnham, Trew & Sneade, 1999). The Arithmetic test was adapted from Lock (2008). Participants had to answer as many questions out of 30 as they could within the experimental time period. The Sentence Checking test (Baddeley, 1968) is a 64 question test designed to measure logic and verbal fluency. It is a test of fluid intelligence. The Wonderlic Personnel Test consists of 50 items, graded in difficulty, testing problem solving using a range of algebraic and geometric techniques. It is considered to be a test of general cognitive ability (fluid and crystallised intelligence) and has a high correlation with the Weschler Adult Intelligence Scale (Wonderlic Personnel Test Inc., 1992).

## **Procedure**

Participants were instructed that they would be asked to complete three tests, whilst listening to a different piece of music during each test. They were given identical instructions and asked to complete as many of the questions on each test as accurately as possible within the 4- minute time period allocated. The participants were run individually, and listened to the pieces of music via headphones set to the same

decibel level. After completing all three cognitive tasks, participants were debriefed and thanked for their participation in the study.

## **Results**

The mean scores were compared to the published norms and scores for similar groups of people in this research programme. They were all well within the normal range.

Insert table 2 here

One-way ANOVAs with planned pairwise contrasts (Guitarists vs. Non-musicians, Guitarists vs. Pianists, Non-musicians vs. Pianists) were used compare to the mean test scores between the participant groups within each task<sup>1</sup>.

For the Arithmetic test, there was no effect of participant group on performance and none of the planned contrasts reached significance. For the Sentence-Checking task there was a significant effect of participant group. One planned comparison reached significance<sup>2</sup>; the performance of the Guitarists (in the presence of guitar music) was significantly poorer than for the Pianists on this task. Finally, for the Wonderlic Personnel test, there was again a significant effect of participant group. The planned comparisons showed that the performance of Pianists (in the presence of piano music) was significantly poorer than for both Guitarists, and Non-musicians.

## **Discussion**

The experimental hypothesis that musicians' performance on a cognitive task would be more impaired when listening to music featuring their chosen instrument rather than another instrument has received partial support. On two tasks (Sentence-checking and the Wonderlic Personnel test) the musicians listening to music played on their chosen instrument had, as predicted, the lowest level of performance. This effect was not evident for the Arithmetic task. This provides partial evidence for our central hypothesis.

The results of the analyses demonstrate the particular distractibility of music for musicians. Though not always significantly so, the test score analysis indicate that musicians have relatively impaired mean performance on cognitive tasks compared to non-musicians. This supports the hypothesis that music processing depletes cognitive capacity (Konecni, 1982). It has already been established that any background noise, including music, tends to have a detrimental effect on cognitive performance for most individuals

when compared to performance in silence, though it depends on the individual, the music and the task (Cassidy & MacDonald, 2007; Furnham & Alllass, 1999; Kiger, 1989).

These results may be explained by the idea that musicians have a greater capacity to follow and understand musical signals and components (Wagner & Menzel, 1979). Musicians are more used to engaging in those cognitive exercises utilized for musical analyses and online temporal processing (North & Hargreaves, 1997), and thus background music has an increased threshold for meaningful processing in musicians compared to in non-musicians (Mikutta et al., 2014).

The results showed not only evidence of increased interference by background music on cognitive task performance within working memory for musicians compared to non-musicians (Salame & Baddeley, 1989; Gathercole & Baddeley, 1993), but also even more interference when the background music featured a listening musician's own respective instrument.

Of the few empirical studies of musicians, it has been shown that certain instrumentalists shown particular trends in personality traits. Kemp (1980) showed that brass players are more Extraverted than other players. Davies and Davies (1978) found that brass players have the lowest scores for neuroticism compared to other instrumentalists, while string players score highest for neuroticism. While it is not certain whether musicians are drawn to their respective instruments to begin as a function of their personality (Marchant-Haycox & Wilson, 1992) personality may be a moderator variable in studies such as this, which warrants testing.

Previous studies have varied aspects of music distractors such as familiarity, loudness, vocal vs instrumental (Dobbs et al, 2011) showing how it can differentially impact on cognitive performance. . This study showed that an interaction between the two, namely that musicians are sometimes distracted by their own instrument. Thus if musicians like to work accompanied by music featuring their own instrument(s) it may expected that this is particularly distracting compared to either no music or that featuring other instruments. This could have implications for how and when musicians choose to listen to music.

We entitled this "a pilot study" as it needs to be replicated to explore many of the issues discussed. There are at least five issues which need attention. First, it is important to extend the number of musical instruments (strings, percussion, wind) to see if the effect holds. Second, participants need to be equivalent in their total musical training, expertise and regular practice in their respective instrument. Third, it is always useful to replicate the effect over a wider range of musical examples chosen and tests used to determine if

there are any specific effects of either. Fourth, it may also be useful to have a “silent condition” where the tests are completed in silence as a control. Finally, to eliminate the possibility of any confounds a full factorial design with task x music listened x musical group may be desirable

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### Footnotes

<sup>1</sup>Factorial ANOVAs were run with participant group as one independent variable and gender as a blocking variable but no significant effects of gender were found: Arithmetic,  $F(1, 54) = 2.64, p = .11$ , Sentence-Checking and Wonderlic,  $F_s < 1$ .

<sup>2</sup>If the assumption of homogeneity of variance is relaxed, and the Welch-Satterthwaite correction applied, the comparison between Guitarist and Non-musicians also reaches significance,  $t(57) = 2.22, p = .033, d = 0.59$ .

Table 1. *The Latin-square experimental design*

		Background Music		
		Guitar Music	Piano Music	Saxophone Music
Cognitive Task	Arithmetic Test	Pianists	Guitarists	Controls
	Sentence Checking Test	Guitarists	Controls	Pianists
	Wonderlic Personnel Test	Controls	Pianists	Guitarists

Table 2. *Mean scores for the three groups with ANOVA results*

	Guitarists (1)	Pianists (2)	Controls (3)	<i>F</i>	<i>p</i> (1 vs. 2)	<i>p</i> (1 vs. 3)	<i>p</i> (2 vs. 3)
Wonderlic Personnel Test	M = 15.70 SD = 3.58	M = 14.00 SD = 3.71	M = 17.10 SD = 2.92	3.69	0.15	0.23	<0 .005
Arithmetic Test	M = 6.20 SD = 3.43	M = 5.70 SD = 3.38	M = 5.89 SD = 2.91	0.10	0.90	0.89	0.87
Sentence Checking Test	M = 26.10 SD = 3.64	M = 33.9 SD = 7.38	M = 33.2 SD = 4.31	3.26	< 0.005	0.68	<0 .005