



The Effects of Background Auditory Interference and Extraversion on Creative and Cognitive Task Performance

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Abstract

The present study examined the effects of different types of background auditory stimuli on the cognitive and creative task performance of introverts and extraverts. A sample of 77 high-school students completed two cognitive tasks (Baddeley Reasoning Test and sentence-completion) and a creative task (Alternate-Uses Test of divergent thinking) under one of four different background auditory conditions (speech, noise, music, or silence), as well as being assessed on Extraversion. Results showed no significant main or interactive effects of background auditory stimuli and personality on either cognitive task performance. However, there was a significant interactive effect on creative performance, with extraverts performing better in the presence of music than introverts. Consistencies and discrepancies with past literature are discussed.

Keywords: Auditory interference, Personality, Extraversion, Creativity, Cognitive, Performance

1. The effects of background auditory interference and personality on creative and cognitive task performance

Recent technological advances have made different modes of music widely accessible (e.g., North, Hargreaves, & O'Neill, 2000; Schwartz & Fouts, 2003), and it is, therefore, not surprising that psychologists have addressed a number of important questions concerning music and other auditory stimuli in everyday life (MacDonald, Hargreaves, & Miell, 2002). For instance, studies have examined the associations between music and social behaviour (e.g., North, Hargreaves, & McKendrick, 2000; O'Donnell, MacDonald, & Davies, 1999), social identity formation (e.g., Tarrant, North, & Hargreaves, 2004), emotionality (Juslin & Sloboda, 2001), and personality (e.g., Chamorro-Premuzic & Furnham, 2007; Chamorro-Premuzic, Swami, Furnham, & Maakip, 2009).

In contrast, much less research has focused on the possible distracting effects of music on cognitive abilities – an important oversight given the amount of time that adolescents in particular spend listening to music (e.g., Schwartz & Fouts, 2003). Indeed, in an early commentary, Konecni (1982) suggested that music processing requires cognitive capacity, such that listening to music should impair cognitive task performance. As a test of this hypothesis, a number of studies have investigated the effects of music presented during a cognitive task, in comparison with other forms of background noise or music (although a handful of studies have also examined the priming effects of music; e.g., see McKelvie & Low, 2002).

Thus, studies examined the effects of background music (e.g., Cassidy & MacDonald, 2007; Daoussis & McKelvie, 1986; Furnham & Allass, 1999; Iwanaga & Ito, 2002), irrelevant speech (e.g., Salamé & Baddeley, 1989), television programmes (e.g., Furnham, Gunter, & Peterson, 1994), and auditory noise (e.g., Belojevic, Slepcevic, & Jakovcevic, 2001; Hygge, Evans, & Bullinger, 2002; Ylias & Heaven, 2003) on cognitive performance. Individual differences in task performance in these studies have typically been interpreted in terms of Eysenck's (1967) theory of personality, which posits that differences in Introversion-Extraversion are largely a function of individuals' levels of cerebral

arousal (how excitable their nervous system is). Specifically, extraverts, who have a higher arousal threshold, seek external stimuli to increase their arousal in order to attain an optimal level, whereas introverts avoid (or reduce) external stimuli to maintain an optimal level of arousal (for a review, see Stelmach, 1987).

In support of this hypothesis, studies have shown that the effects of background auditory interference on task performance are different for extraverts and introverts. Daoussis and McKelvie (1986), for instance, demonstrated that, in the presence of music, introverts' performance on a reading comprehension task was significantly lower than that of extraverts', when compared with performance in silence. Furnham and Bradley (1997) extended these findings by assessing levels of distraction of radio extracts on memory recall and a reading comprehension task. They found that, in both cases, introverts were more significantly affected by the distraction than were extraverts. More recently, Furnham and Allass (1999) looked at the effect of 'simple' and 'complex' music on the performance of introverts and extraverts, finding that complex music tended to impair the performance of introverts but improve that of extraverts. Finally, in a recent study, Cassidy and MacDonald (2007) reported that introverts were more detrimentally affected by the presence of high arousal music compared with extraverts.

Other studies have looked at the distracting effects of noise rather than music. On mental arithmetic and prose recall tasks, for instance, Banbury and Berry (1998) found that performance was significantly poorer in the presence of unpredictable office noise when compared to performance in silence (see also Evans & Johnson, 2000). However, these studies did not consider personality differences in relation to task performance. To overcome this limitation, Belojevic et al. (2001) explored whether an individual's level of Introversion had an effect on a mental arithmetic task in the presence of recorded traffic noise. They found that among introverts, there was a marked deterioration in performance, while extraverts worked faster in the noise condition in comparison to a quiet condition.

More recently, Furnham and Strbac (2002) examined whether music is as distracting as noise, with participants completing reading comprehension, prose recall, and mental arithmetic tasks in the presence of background garage music and office noise. They found that introverts performed significantly poorer than extraverts on the reading comprehension task in the presence of music and noise, but that the distracting effects of music and noise were not significantly different when completing prose recall and arithmetic tasks. The contradictions between this and earlier studies (e.g., Banbury, & Berry, 1998) might be due in part to the different tasks that have been used: Konz (1962), for instance, found that music detrimentally affected a letter-matching task but not a manual assembly task (see also Furnham & Bradley, 1997).

Yet other studies have investigated the effects of background speech on cognitive performance (e.g., Morgenstern, Hodgson, & Law, 1974). In one study, Salamé and Baddeley (1989) found a distracting effect of irrelevant speech on immediate serial recall, while Jones, Miles, and Page (1990) demonstrated that the more meaningful the speech, the more detrimental its effect on performance. More recently, Furnham, Trew, and Sneade (1999) asked introverts and extraverts to complete reading comprehension and logic-problem and coding tasks in the presence of vocal and instrumental music. In this study, introverts reported that vocal music was more distracting than instrumental music, although there was no significant difference in their performance in the presence of either simple or complex music.

1.1 The Present Study

In short, although previous work has generally suggested that background auditory stimuli is more detrimental for task performance by introverts compared with extraverts, the extant literature is complicated by the use of a range of different types of auditory stimuli and measures of task performance. In the present study, we sought to disambiguate some of these concerns by examining whether different types of background auditory interference would significantly impair cognitive task-performance (cognitive reasoning and sentence-completion) among introverts and extraverts. Specifically, we examined three different types of background auditory interference (music, noise, and dialogue speech compared with silence) in order to assess their comparative interference effects on performance, and whether they interact with Extraversion level. Based on the above review, we expected that extraverts would evidence better cognitive task performance than introverts on all three noise conditions.

In addition, the present study extended previous work by investigating the effects of background auditory interference on creative task performance. Guilford (1950, 1967) proposed several distinctions in creativity, including ideational fluency (ability to produce ideas within a time frame), convergence (choosing ideas that are frequent within a group), and divergence (ability to choose unusual associations of ideas). Various studies have shown that the personality factors of Openness to Experience and Extraversion are consistently associated with these different aspects of creativity (for a review, see Batey & Furnham, 2006). To date, however, no study has examined the effects of personality and background auditory interference, or a combination of both, on creative task-performance (in this study, operationalised as divergent thinking or ideational fluency). As such, this part of the study was exploratory in nature, although we did expect auditory interference to have a detrimental effect on creative task-performance for introverts more than extraverts (given the similar task demands that creativity has compared with cognitive tasks).

2. Method

2.1 Participants

Participants of the study were 77 high-school students, of whom 60 were women and 17 were men (Note 1). These participants had a mean age of 17.09 years ($SD = 0.59$, range = 16-18 years), were of European Caucasian descent, and self-reported English to be their first language.

2.2 Background Stimuli

In relation to music stimuli, it may be expected that greater listening frequency might lead to greater liking and predictability of tracks and, in turn, lead to decreased perceptions of stimuli complexity and arousal. We, therefore, only selected songs that had not been released into national music charts as of April 2001 (when the study was conducted). Moreover, because preference for music is known to affect task performance (Furnham & Bradley, 1997), music stimuli in the present study were compiled from four different genres representing pop (Kylie Minogue with 'Give It To Me'), R&B (Brandy's 'Can We?'), hip hop (Ja Rule's 'Lost Little Girl'), and alternative (the Red Hot Chilli Peppers with 'The Velvet Glove'). The first minute of each song was recorded on audio cassette and was separated by a 0.50-second gap to reduce disruption during the experiment. Noise stimuli were recorded from the BBC *Sound of the City* compact disc series, and consisted of general office noise and featured telephone ringing lasting 4 minutes. Finally, 4 minutes of dialogue speech was extracted from *The Archers* series featured on BBC Radio 4.

2.3 Measures

The Baddeley Reasoning Test (BRT; Baddeley, 1968). This is a 64-item test administered in three minutes and that measures logical reasoning abilities. The test consists of 64 sentences describing the order of two given letters (e.g., AB or BA) and for which participants have to verify the logical validity within 3 minutes. A point is scored for each correct answer, and scores can range from 0 to 64 (higher scores refer to greater cognitive ability on this task). The test has been employed previously in several studies (e.g. Furnham et al., 1994) to obtain a quick and reliable indicator of people's intellectual ability. However in the current study it was used to operationalise logical verbal reasoning under different auditory distractions.

The Scholastic Aptitude Test (SAT). Ten sentence-completion items were taken from the SAT and required participants to choose a word or set of words that provided the appropriate meaning from a sentence with omitted word or words. The 10 sentences chosen for the present study were used in a pilot test ($N = 10$, 5 women, 5 men) to ensure the appropriate level of difficulty. Participants were given 4 minutes to complete the task, and scored a point for each correctly completed sentence. Scores ranged from 0 to 10, with higher scores referring to greater cognitive ability on this task.

Alternate-Uses Test (Christensen, Guilford, Merrifield, & Wilson, 1960). To measure fluency of creative performance (also known as ideational fluency or divergent thinking), we used a modified example of the Alternate-Uses Test in which participants were requested to name alternative uses for everyday objects. Participants were given 1 minute to write down as many answers as they could for 4 objects adapted from Guilford (1959): *paper clips*, *spoon*, *cork*, and *shoelaces*. The task was tested in a pilot study ($N = 10$, 5 women, 5 men) to ensure that a variable number of answers could be obtained. Performance on the task was measured in terms of ideational frequency, with participants receiving a score for every idea generated. For all subsequent analyses, fluency scores were z-transformed for the univariate analyses in order to facilitate interpretation of results (higher scores refer to greater creative task performance).

The Neuroticism-Extraversion-Openness Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992) was used to assess Extraversion. This is a 60-item, non-timed questionnaire that also assesses four other personality traits, not used in the current study (Neuroticism, Openness to Experience, Agreeableness, and Conscientiousness). Items – 12 for Extraversion – involve questions about typical behaviours or reactions that are rated on 5-point Likert scale (0 = *Strongly disagree*, 4 = *Strongly agree*). The NEO-FFI manual reports good indicators of reliability and validity (Costa & McCrae, 1992). In the present study, participants were categorised as either extraverted or introverted using a median split (introverts $n = 39$, extraverts $n = 38$).

Post-test questionnaire. Participants completed a post-test questionnaire to determine their level of distraction experienced in the presence of music, noise, and dialogue speech (1 = *Not at all distracted*, 4 = *Very distracted*). In addition, participants indicated how often they studied with music on a 4-point scale (1 = *Never*, 4 = *Always*).

2.4 Procedure

Once ethical permission and informed consent was obtained, participants completed the tasks in one of four groups ($n_1 = 21$, $n_2 = 17$, $n_3 = 17$, $n_4 = 22$), with seating arranged in a circle to prevent social contagion effects. A trained experimenter read out standardised instructions before the experiment began and answered participants' questions. Participants then completed the two cognitive and one creative problem-solving tasks. The order in which each group completed the tasks was counterbalanced using the Latin-square arrangement. Groups completed a task in the presence

of music (the order of genre was counterbalanced), noise, dialogue speech, or silence. The background sound was played on a CD in the middle of the room (approx. 8 feet from participants) at a moderately loud level (approx. 25 decibels) to ensure that the sound pressure level was relatively similar for all participants seated in the circle). Upon completion of the tasks, participants completed the NEO-FFI and post-test questionnaire. The entire experiment lasted approximately 35 minutes and participants were verbally debriefed at the end of the procedures. All participants took part on a voluntary basis and were not remunerated for participation.

3. Results

3.1 Descriptive Statistics

Means and standard deviations for the two cognitive ability tests (BRT and SAT) and ideational fluency are reported in Table 1.

3.2 Analyses of Variance

A 4 x 2 (4 levels of auditory stimuli: music, noise, dialogue speech, silence; 2 levels of personality: extraverts versus introverts) ANOVA with BRT scores as the dependent variable showed no main effect of personality, $F(1, 69) = 0.78$, ns , $\eta_p^2 = .01$, nor a main effect of auditory interference, $F(3, 69) = 0.81$, ns , $\eta_p^2 = .01$. In addition, there was no significant interaction between personality and auditory interference, $F(3, 69) = 0.76$, ns , $\eta_p^2 = .01$. When the same analysis was repeated with sentence-completion scores as the dependent variable, results once again showed no significant main effect of personality, $F(1, 69) = 1.79$, ns , $\eta_p^2 = .02$, or of auditory interference, $F(3, 69) = 0.94$, ns , $\eta_p^2 = .01$. Nor was there a significant interaction between personality and auditory interference, $F(3, 69) = 0.24$, ns , $\eta_p^2 = .01$.

Finally, the same 4 x 2 ANOVA for ideational fluency showed no main effect of personality, $F(1, 69) = 1.27$, ns , $\eta_p^2 = .02$, and no main effect of auditory interference, $F(3, 69) = 0.67$, ns , $\eta_p^2 = .02$. There was, however, a significant interaction between personality and auditory interference, $F(3, 69) = 3.00$, $p < .05$, $\eta_p^2 = .12$. This interaction is graphically represented in Figure 1. Tests of simple effects showed that extraverts performed better than introverts in the presence of music, $t(15) = 2.98$, $p < .05$, $d = 1.51$, but that there were no significant between-group differences in the presence of speech, noise, or silence (all $ts < 1.53$, all ns).

3.3 Post-Test Questionnaire

Pearson's correlations were carried out to examine the relationship between Extraversion (in this instance, used as a continuous variable) and ratings on the post-test questionnaire. Results showed no significant correlations between Extraversion and how distracting participants found dialogue speech ($r = -.10$, $p > .05$), music ($r = .04$, $p > .05$), or noise ($r = -.10$, $p > .05$). By contrast, there was a significant positive correlation between Extraversion and individuals' likelihood of studying with background music ($r = .82$, $p < .001$).

4. Discussion

In the present study, we sought to investigate the effects of different types of auditory interference on the cognitive and creative task performance of introverts and extraverts. Our results showed that there were no significant effects of auditory interference or personality on either of the cognitive tasks (BRT and SAT), which stands in marked contrast with the extant literature. However, the results also showed a significant interaction between auditory interference and personality on ideational fluency. Below, we discuss these results in greater detail, beginning with the significant interaction before suggesting possible reasons for the lack of significant effects in relation to the two cognitive tasks.

To our knowledge, this is the first study to have examined the effects of auditory interference on creative task performance. Our results showed that extraverts performed better on ideational fluency in the presence of music than introverts, but that there were no significant between-group differences in the presence of background noise, speech, or silence. In general, this finding is consistent with Eysenck's (1967) proposal that introverts experience greater arousal in response to a lower intensity of stimulation than extraverts. As a consequence, introverts may perform more adversely than extraverts under conditions (e.g., in the presence of background music) where they level of arousal rises beyond optimal functioning.

An important question that arises from our results is: why should music interfere with creative task performance but not cognitive abilities? One possibility is that ideational fluency is predicated upon a basic level of cognitive ability, but that the latter only accounts for a small percentage of the former (e.g., Furnham, Nederstrom, & Swami, 2008; Silva, 2008). As such, creative and cognitive tasks may be reasonably assumed to tap different abilities, resulting in the differential pattern of results seen in our study. An alternative possibility is that auditory interference in fact does not substantially affect creative task performance. This explanation is lent support by the relatively modest effect size of the interaction between auditory interference and personality, as well as the lack of significant main effects.

In contrast to the results for ideational fluency, our results suggest that there were no main effects or interactions between personality and auditory interference in relation to the BRT and sentence-completion. In general, these results stand in contrast to previous work showing that the effects of auditory interference is different for extraverts and introverts (e.g., Banbury & Berry, 1998; Belojevic et al., 2001; Cassidy & MacDonald, 2007; Daoussis & McKelvie, 1986; Furnham & Allas, 1999; Furnham & Bradley, 1997; Furnham & Strbac, 2002). One likely explanation for this discrepancy is that the effects of auditory interference on cognitive abilities are related to task-related factors, such as the complexity of a task. For instance, a number of studies have suggested that auditory interference is more likely to affect task performance on complex, rather than simple, mental tasks (e.g., Furnham & Bradley, 1997; Iwanaga & Ito, 2002). It might be speculated, therefore, that the cognitive tasks used in the present study (BRT and sentence-completion) were not sufficiently complex to elicit significant effects of auditory interference.

Finally, the results of the correlations obtained from the post-test questionnaire suggest that more extraverted individuals were more likely to study in the presence of music. In other words, this result suggests that introverts and extraverts may have different study habits, corroborating previous findings by Furnham and Bradley (1997) and Furnham and Strbac (2002). By contrast, there were no significant correlations between Extraversion and how distracting participants found dialogue speech, music, or noise. It should be noted, however, that these were fairly simple statistical analyses, and future work would do well to include more sophisticated methodological designs and analytical tools.

An important limitation of the present study is that, although we used music from different genres, we did not explicitly take genre into consideration in our analyses. Previous work has suggested that the modality and tempo of music may interact with cognitive task performance and productivity (e.g., Blood & Ferriss, 1993). For instance, calming music may improve arithmetic and memory abilities, whereas aggressive or high-tempo music may disrupt performance (Hallam, Price, & Katsarou, 2002). In addition, we did not measure participants' level of arousal or mood, which may be important mediators of the effects of music on task performance (Hallam et al., 2002).

Future work could also improve on our design in a number of ways. For instance, in order to control for possible between-group differences in noise level, participants could be tested with earphones (this would also allow researchers to test the impact of volume on task performance). In addition, future research could examine the role of other Big Five personality factors on cognitive and creative task performance in the presence of auditory distracters, given that much of the research is currently focused on Extraversion-Introversion. The operationalisation of creativity could likewise be varied, based on Guilford's (1950, 1967) definitions. Finally, further study should also seek to utilise a larger sample with a more even gender split.

In conclusion, the present results suggest that background music may have a more detrimental effect on the creative task performance of introverts compared with extraverts. In addition, the effects of auditory interference on cognitive performance may be mediated by the type of task being performed in the presence of noise, speech, or music. Given the wide appeal and accessibility of music (e.g., North et al., 2000), our results may be relevant not only for high-school students, but also for individuals in other settings seeking to maximise their productivity and task-related performance. What is required of future work is more sophisticated methodological designs that take into consideration the many different aspects of music, including emotional, physiological, social, and cultural factors.

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Note

Note 1. Given that previous work has not generally reported sex differences in the effects of auditory stimuli on task performance (e.g., Cassidy & MacDonald, 2007; Furnham & Allass, 1999; Furnham & Bradley, 1997), we did not expect the large number of women compared to men in the present study to have any major effect on the results.

Table 1. Mean scores and standard deviations for the Baddeley Reasoning Task (BRT), sentence completion (SAT), and Alternate-Uses Test (Fluency) under conditions of dialogue speech, noise, music and silence

		Introverts				Extraverts			
		Speech	Noise	Music	Silence	Speech	Noise	Music	Silence
BRT	<i>M</i>	13.55	18.86	13.85	19.88	20.09	17.80	18.38	18.22
	<i>SD</i>	6.47	14.28	7.58	9.16	10.63	9.19	16.72	7.07
SAT	<i>M</i>	5.69	5.25	5.00	6.36	6.63	5.89	5.90	6.36
	<i>SD</i>	2.14	2.12	1.00	0.92	1.41	2.85	2.08	2.33
Fluency	<i>M</i>	7.84	6.16	9.27	9.20	8.75	9.69	7.92	8.86
	<i>SD</i>	2.85	2.12	2.04	8.86	2.69	2.57	1.68	3.27

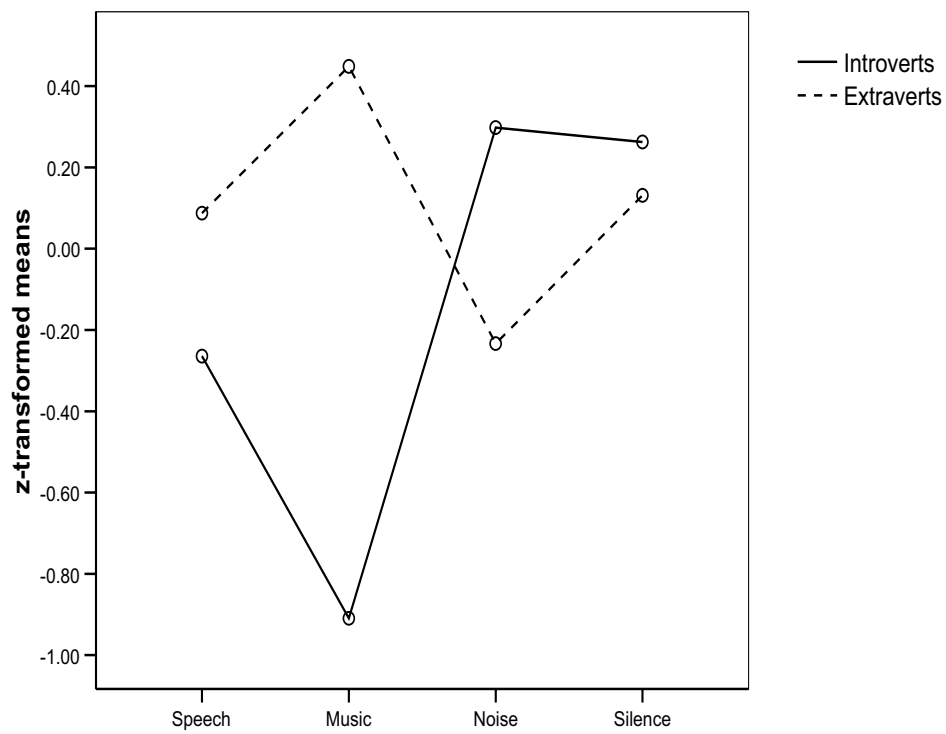


Figure 1. Graphical representation of the significant interaction between personality and auditory interference on ideational fluency. Higher scores on the dependent variable (ideational fluency) represents better performance on this task