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Music is as distracting as noise: the differential distraction of background music and noise on the cognitive test performance of introverts and extraverts

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Previous research has found that introverts' performance on complex cognitive tasks is more negatively affected by distracters, e.g. music and background television, than by extraverts' performance. This study extended previous research by examining whether background noise would be as distracting as music. In the presence of silence, background garage music and office noise, 38 introverts and 38 extraverts carried out a reading comprehension task, a prose recall task and a mental arithmetic task. It was predicted that there would be an interaction between personality and background sound on all three tasks: introverts would do less well on all of the tasks than extraverts in the presence of music and noise but in silence performance would be the same. A significant interaction was found on the reading comprehension task only, although a trend for this effect was clearly present on the other two tasks. It was also predicted that there would be a main effect for background sound: performance would be worse in the presence of music and noise than silence. Results confirmed this prediction. These findings support the Eysenckian hypothesis of the difference in optimum cortical arousal in introverts and extraverts.

1. Introduction

There has been considerable interest into how background sounds may influence an individual's performance on various cognitive and work tasks. This area of research is of particular interest to industrial psychologists and ergonomists who may wish to assess whether productivity can be increased in the presence of background music at work (Cantril and Allport 1935, Kirkpatrick 1943, Uhrbrock 1961). In addition, technological advances, such as the personal stereo and the recent trend of music being played in everyday settings (such as shops and hospitals) has demonstrated the widespread use of music, presumably to change behaviour (Oldham *et al.* 1995). There is also a significant literature on how other types of background sound, such as office noise, may influence cognitive performance and personal annoyance (Sailer and Hassenzahl 2000).

The limited research focusing on the effects of noise has found, as one would intuitively predict, that background noise is a source of stress and has a detrimental effect on cognitive performance (Kjellberg *et al.* 1996). Evans and Johnson (2000)

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recently demonstrated the negative effects of open-plan office noise. Forty female clerical workers were required to type into a computer a manuscript of unfamiliar content. This task was representative of tasks carried out by them in day-to-day work. Participants either word-processed in a quiet setting or in a setting with low-intensity noise designed to simulate typical open-plan office noise levels. Results demonstrated the negative effects of the noise. Although the performance of the two groups was the same, those in the noise condition had elevated urinary epinephrine levels (a marker of stress) and had the after-effect of motivational deficits, indicated by fewer attempts at unsolvable puzzles. In addition, they made less postural adjustments, which is a risk factor for musculoskeletal disorder.

Banbury and Berry (1998) used more complex tasks in their study of noise distraction, although they were still representative of tasks conducted in office environments. They found that undergraduates' performance on a mental arithmetic task and a prose recall task was significantly worsened in the presence of office noise (with or without speech) than when compared to performance under silence. They concluded that noise disrupted performance due to the unpredictability and hence distracting quality of the noise. Thus, not only is noise stressful and detrimental to health and motivational levels, as suggested by Evans and Johnson (2000), but it can also have a negative impact on workers' performance on complex cognitive tasks. However, few studies in this area examined individual difference factors in reactions to noise (Weinstein 1978). An exception is the work of Belojevic *et al.* (2001) who looked at concentration problems, fatigue and noise annoyance under quiet and noisy conditions of introverted and extraverted medical students. Introverts were slower than extraverts in the noisy condition and reported more concentration problems and fatigue during mental processing.

There is also an experimental literature on the potential benefits and drawbacks of background music at work (Hargreaves and North 1997). The research has noted the interaction between the type of task, the type of music and individual differences in understanding the distractibility of music at work (Furnham 2001). The results of many early studies seem equivocal mainly because of different tasks used. For example, Konz (1962) found that college students' performance on two routine tasks, a manual assembly task and a letter matching task, improved by 18% and 17%, respectively, in the presence of music. However, Kirkpatrick (1943) found that music hinders performance on tasks demanding mental concentration, while McGehee and Gardner (1949) found that music actually had no effect on tasks involving mental concentration. A more recent study by Oldham *et al.* (1995) found that employees who listened to music through a personal stereo for 4 weeks had improved performance, turnover intentions, organization satisfaction and mood states. However, one problem with this study is that participants were self-selected and expressed a desire to work while listening to music. Smith (1961) highlighted the fact that music may have a different impact depending on the tasks being conducted. Music, he hypothesized, may have a positive effect for routine tasks as it serves to reduce the tension and boredom associated with these tasks but for complex mental tasks, music may act as a distracter. He provided evidence for the first claim but found that for complex tasks music had no significant effect at all.

Other research into the effects of music on task performance has examined the effects of different types of music in order to establish whether they produce different effects on task performance (Furnham *et al.* 1994). Findings have been inconsistent. Williams (1961) and Fogelson (1973) found that popular instrumental music reduced

performance on a reading comprehension task. Rauscher *et al.* (1993) found that spatial IQ scores were better in the presence of some of Mozart's music; however, Williams (1961) found that classical music had no effect on a reading comprehension task. Furnham and Bradley (1997) examined performance on an immediate and delayed recall memory task and reading comprehension task in the presence of background vocal pop music. Negative effects of music were found on the former task only. Other research has looked at the complexity of the music. Kiger (1989) found that scores on a reading comprehension task were higher in a 'low information load music' condition than in either silent or a 'high information load condition' whereby information load was measured by rhythmic complexity, tonal range and repetition. However, Furnham and Allass (1999) found no difference in performance on a reading comprehension task, memory recall task and spatial task in the presence of complex and simple music as rated on factors such as tempo, repetition and instrumental layering. Furnham *et al.* (1999) examined whether there would be a difference in performance on a reading comprehension task, a logic problem and a coding task in the presence of silence and background vocal and instrumental music. Results indicated that only on the logic task did instrumental music increase performance.

However, it is difficult to compare the studies as they employ different tasks and different types of music, which have resulted in the varied findings. What does seem to emerge from the research is that music is more likely to have an effect on task performance if it is a complex mental task, particularly reading comprehension tasks.

A small number of studies have looked at how individual difference factors interact with background music to influence task performance. If it is assumed that music is stimulating, then an individual's levels of performance should relate to their individual level of arousal. Eysenck (1981) has demonstrated how introverts have a lower level of optimum arousal and extraverts a higher level of arousal. Stelmach (1981) reviewed the extensive psycho-physiological evidence that supports this hypothesis. Introverts and extraverts have different optimum levels of arousal, with introverts having a lower level and extraverts a higher level, thus it could be expected that background music, which increases levels of arousal, will have a more negative affect on introverts as it causes them to be beyond their optimum functioning level. In contrast, extraverts, who have a higher level of optimum cortical arousal, will not exceed their optimum functioning level. Campbell and Hawley (1982) provided evidence of the regulation of arousal differences between introverts and extraverts. They found that, when studying in a library, extraverts were more likely to choose to work in areas with bustle and activity while introverts were more likely to choose a quiet area, away from this noise.

Several studies examined whether introverts' performance was worse than that of extraverts in the presence of music. An early study in this area by Daoussis and McKelvie (1986) confirmed this prediction. Introverts and extraverts were administered a retention test for two passages of text in the presence of music or silence. While extraverts' scores were similar in both conditions, introverts' scores were significantly poorer in the presence of music as compared to silence.

Morgenstern *et al.* (1974) examined whether there was a relationship between habits of work performance and personality type. They gave introverts and extraverts a list of words to remember, which were read out by a voice; concurrently the same voice read a passage of text to them. They were able to control the balance of sound between the list of words and the passage but at the expense of increasing

the distortion of the list of words. Results indicated that there was a trend for introverts to avoid distraction and when they did adjust the balance, they did so with a few small adjustments compared to the extraverts' exaggerated sweeping movements. This supports Eysenck's view that the introvert's nervous system is over-damped and demonstrates that while their performance decreases in the presence of distraction, the extraverts' performance actually improved.

Furnham and Bradley (1997) asked introverts and extraverts to complete two cognitive tasks, namely a memory recall task and a reading comprehension task. Performance was significantly worse for the introverts in the presence of music but there was no significant difference between the introverts' and extraverts' scores when the tasks were conducted in silence. Later, Furnham and Allass (1999) examined whether the increasing complexity of the music may have an increasingly negative effect for the introverts' performance. Results indicated that as the complexity of the music increased, introverts' performance on an observation task and on a memory recall task decreased while extraverts' performance increased. They proposed that this could be attributed to the introverts' excitation-inhibition mechanism when subjected to over-arousal.

This study aims to extend Furnham and Bradley's study (1997). There has been a relative paucity of research examining whether personality differences will occur on performance in the presence of noise. Although research, as described earlier, has focused on the negative effects of noise generally, it has not examined the effects of individual personality differences. Early research by Binaschi and Pelfini (1966) demonstrated how introverts and extraverts, as determined by the Perugia questionnaire, had a differential performance in the presence of noise on a visual and auditory reaction task, with extraverts having significantly shorter reaction times. This study aimed to determine whether there would be a differential distraction of background noise and music on the cognitive test performance of introverts and extraverts on three kinds of task. Two of these tasks were the same as those used by Banbury and Berry (1998) and the third was similar to the reading comprehension task used by Furnham and Bradley (1997). The tasks were specifically selected in order to be as ecologically valid as possible: the *prose recall* task relates to examination strategies at any level of education; while the *reading comprehension* task, which involves assimilating information, involves absorbing and understanding information and then recalling it. Finally, the *mental arithmetic* tasks are also often conducted in working environments, such as calculating pay and producing figures.

All of the tasks are mentally involving. It was predicted that there would be a similar pattern of results for all three tasks. Banbury and Berry (1998) found that background sound affected both a verbal and a numerical task. In addition, differential performance of introverts and extraverts in the presence of distraction has been found under various tasks, such as visual and auditory reaction tasks (Binaschi and Pelfini 1966) and reading comprehension tasks and memory recall tasks (Furnham and Bradley 1997). Thus it appears that it does not matter what type of task is used in order to result in a differential distraction of background sound on the test performance of introverts and extraverts. Rather it is that introverts, who have a lower level of optimum cortical arousal, reach and exceed their optimum functioning level more than extraverts on various tasks in the presence of distraction.

This study used complex, vocal music as has previous research; Kiger (1989) and Furnham and Bradley (1997) have found that this is more likely to have an impact on task performance than less complex, instrumental music (Williams 1961). In addition, the music also aims to be as similar as possible to music that would be heard in everyday settings, for example, on the radio, in order to increase the ecological validity of the findings. Office noise was also used in this study in order to make the results more applicable to work settings where the effects of noise is an important consideration.

The experimental hypotheses were as follows.

> *Hypothesis 1.* There would be a main effect for background sound, whereby performance for both introverts and extraverts would be best in silence, followed by music and worse in the presence of background noise.
>
> *Hypothesis 2.* There would be an interaction on each of the three tasks between personality and the distracting effect of background music and noise, whereby the performance of introverts would be significantly worse than the performance of extraverts in the presence of background music and noise, but not silence.

In addition, this study also examined whether there are any relations between an individual's personality type, their study habits and how distracting they find the background sound in this study as determined by a post-test questionnaire. It was predicted that extraverts would be more likely to report studying in the presence of music and less likely to report being distracted by the background sound. This is in line with the claims of the regulation of arousal differences between introverts and extraverts and previous research that has found that extraverts are more likely to study in noisier places than introverts (Campbell and Hawley 1982). In addition, other research, such as that of Furnham and Bradley (1997) found a correlation between self-reported levels of distraction throughout their experiment and extraversion and self-reported habits of studying with music and extraversion.

It was predicted that there would be a correlation between personality and ratings on the post-test questionnaire with more extraverted individuals being more likely to report studying with music and less likely to report finding the music and noise distracting throughout this present experiment.

2. Method

2.1. *Participants*

Seventy-six sixth-form students, 33 males and 43 females, completed the Eysenck Personality Questionnaire (EPQ, Eysenck and Eysenck 1975) in order to assess their scores on the introversion-extraversion scale. The median was calculated to produce an extraverted and introverted sample. Thirty-eight participants were classified as extraverted (mean EPQ score [for extraversion scale], 11.65; mean age, 16.75 years). Eighteen of the extraverts were males and 20 were females. Thirty-seven participants were classified as introverted (mean EPQ score [for extraversion scale], 7.60; mean age, 17.39 years). Fifteen of the introverts were males and 23 were females. All subjects spoke English as their first language.

2.2. *Materials*

2.2.1. *Sound*: The noise was produced from the BBC's SFX CD of 'Essential Sounds of the City'. The particular extract of noise was created on an IBM Pentium III laptop using the programme Cool Edit Pro to mix the selected sounds together. The samples used from 'Essential Sounds of the City' were office noise, which contained people mumbling and general office noise, added to this, by using Cool Edit Pro, were telephones ringing, faxes ringing and people typing on typewriters. The length of the finished piece was 12 min 37 s; however, it was only played for the duration of each task. The noise was selected so as to be as representative as possible of everyday office noise.

Although noise is common it is nearly always novel due to the fact that it is nearly impossible for exactly the same bit of noise to be heard more than once as its precise pattern will ultimately vary from time to time; for example, workmen drilling will never sound exactly the same each time this sound is heard. Therefore, it was vital that the music used was novel also. The pieces selected were unreleased UK Garage-style music. This was chosen as Garage music is frequently heard in the charts and on the radio and thus the music style was familiar. However, because the music was unreleased at the time of the study it ensured that the music was also novel. Thus all these pieces had a high tempo, were non-repetitive, were vocal and had much instrumental layering. The exact songs chosen were Bills to Pay by Zed Bias, Love Shy by Kristen Blonde, Goodfellas by 51st Recordings and Messin Around by Wideboys. A professional DJ mixed these songs so that there were no gaps between the songs. The total length of the music was 13 min 5 s; however, it was only played for the duration of each task. The sound was presented via a cassette player that was placed at the front of the room. Decibel levels were not measured but all music was played at the same level.

2.2.2. *Tasks*: The tasks were at an appropriate level of difficulty for the sample. The reading comprehension task was similar to the one used by Furnham and Bradley (1997) but was simpler as a younger age group was being tested. The mental arithmetic and prose recall tasks were the same as those used by Banbury and Berry (1998). All three tasks were mentally taxing and similar to those found in everyday settings.

(1) The reading comprehension task was extracted from the SHL Practice Tests Series 2 (Saville and Holdsworth 1993). This consisted of seven passages and four multiple-choice questions for each passage based on the text (thus 28 questions in total). For each question the subject had to determine whether the statement was true, false or could not be answered from the passage. The subjects were given 7 min with which to complete the test. They were awarded one point for each correct answer and no points for an incorrect answer, allowing a maximum possible score of 28 points.

(2) The memory for prose task consisted of a passage of text approximately 150 words long. It was adapted by Banbury and Berry (1998) from a martial arts book, which gave the proper and improper method of stretching muscles. Subjects were given 5 min to learn the passage. Subjects were asked to recall this passage as accurately as they could after a 5-min delay. It was scored by

breaking it down into 13 units: 2 points were given for an exact word-for-word answer, 1 point was given if either half the words were recalled exactly or if they were recalled exactly but in the wrong order. Zero points were given if fewer than half the words in each section were recalled. Thus the maximum possible score was 26 points. In the 5-min interval subjects were asked to write down all the words they could think of that began with the letter T onto a blank piece of paper. The purpose of this was to divert the subject's attention away from the passage they had previously memorized and thus the subjects' results were not included in the analysis.

(3) The mental arithmetic task consisted of 12 sets of 15 single-digit sums. Six of these were addition only and the remaining six were both additions and subtraction. This task was presented on a piece of paper. Subjects were awarded one point for each correctly answered sum, thus producing a maximum total score of 12 points.

A stopwatch was used to time the tasks. The subjects were given the EPQ at the start of the experiment and were asked a few questions in order to collect their personal details. They were also asked to indicate their fatigue levels. The subjects were also given a post-test questionnaire that asked them to indicate on a 7-point Likert scale how motivated they were and how distracting they found the music and noise. They were also asked to indicate how often they usually worked with music and noise on a 7-point Likert scale.

2.3. *Procedure*

Subjects completed the tasks in groups of 8 to 21 subjects. Subjects were seated so that they could not see any other individual's responses. Subjects first completed the pre-test questionnaire and EPQ. All subjects then completed the reading comprehension task, prose recall task and mental arithmetic task. Each subject completed one task in the noise condition, one in the music condition and the last in the silent condition. The background sound was played on a cassette player at the front of the room. A Latin Square was used to counterbalance the design so that each music condition was counterbalanced with each task and each combination occurred with an equal frequency. In addition the order of the tasks was randomized.

On completion of the tasks the subjects were given a post-test questionnaire that asked them to rate on a 7-point Likert scale how distracting they found the noise and music and how motivated they were. They were also asked how often they usually worked/studied with noise and/or music in the background. In total the mean experiment time was approximately 40 min.

3. Results

The experimental data obtained separately from each cognitive task were analysed using a 2×3 between-subjects ANOVA. The data suggest that for all three tasks, performance for all subjects declined in the presence of music and noise compared to silence, however, extraverts' performance was higher than that of introverts when in the presence of music and noise (table 1).

The experimental data from each cognitive task were then analysed separately. Three 2×3 between-subjects ANOVAS demonstrated no significant gender

Table 1. Table of mean scores and standard deviations for the reading comprehension, prose recall and mental arithmetic tasks under conditions of silence, music and noise.

	Extraverts			Introverts		
	Noise	Music	Silence	Noise	Music	Silence
*Reading comprehension**						
Mean	21.58	23.00	24.33	16.08	17.36	23.53
SD	5.28	3.97	3.37	4.48	2.54	2.87
Prose recall†						
Mean	3.82	5.47	7.25	2.72	4.53	7.58
SD	1.88	4.16	3.05	1.79	4.03	2.64
Mental arithmetic‡						
Mean	5.07	5.83	5.91	4.13	5.00	6.09
SD	2.25	2.26	1.70	2.19	2.75	1.97

*Maximum possible score of 28.
†Maximum possible score of 16.
‡Maximum possible score of 12.

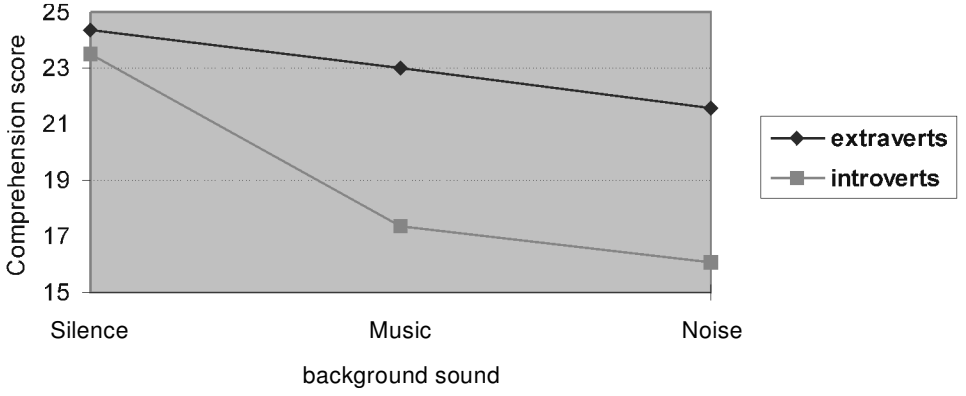

Figure 1. Mean scores of introvert's and extravert's performance on a reading comprehension task, in the presence of background music, noise and silence.

differences indicating that there was not a differential performance for each gender under the different background sounds.

3.1. *Reading comprehension*

The results are shown graphically in figure 1.

A 2×3 between-subjects ANOVA showed a main effect for introversion/extraversion ($F(1,70) = 20.19$, $p < 0.001$) indicating that there was a significant difference in the performance of introverts and extraverts. There was a main effect for background sound ($F(2,70) = 13.01$, $p < 0.001$) indicating that there was a significant difference in performance with the different background sounds. This supports the first hypothesis. There was also a significant interaction between the personality dimensions and background sound dimensions ($F(2,70) = 3.52$, $p < 0.05$) indicating that the two main effects were differential across conditions. This supports the second hypothesis.

Further analyses were conducted to confirm whether this interaction was due to the decline of the performance of the introverts from the silent condition, through the music and noise background conditions. Three independent *t*-tests were employed to test this. Results indicated that there was no significant difference between introverts' and extraverts' performance in the silence condition ($t(28) = 0.70$ ns). There was a significant difference between introverts' and extraverts' performance in the presence of music ($t(20) = 2.83$, $p < 0.01$) and in the presence of noise ($t(22) = 2.65$, $p < 0.02$ ($p = 0.01$)). Using the Bonferroni method to control for the familywise error rate and therefore to reduce Type I error the results are still significant at $p < 0.05$. These results therefore suggest that the reason for the main effect of personality (i.e. introverts and extraverts performing significantly different overall in the experiment) was due to the presence of background stimulation, as their performance did not differ in the silence condition.

Independent *t*-tests were also carried out to examine where the main effects for background sounds were. Results indicated that performance was significantly worse under the music condition when compared to silence ($t(50) = 3.63$, $p < 0.001$). Employing the Bonferroni method to control for the familywise error rate the results remain significant. There was no significant difference in performance when comparing performance under the music condition with that in the noise condition ($t(44) = 0.91$, n.s.). Thus performance was worse in the presence of music and noise than compared to silence but performance did not differ significantly under the music and noise conditions.

3.2. *Prose recall*

The results are shown graphically in figure 2.

A 2×3 between-subjects ANOVA showed no main effect for introversion/extraversion ($F(1,70) = 0.58$, n.s.) indicating that there was not a significant difference in the performance of introverts and extraverts. There was a main effect for background sound ($F(2,70) = 9.80$, $p < 0.001$) indicating that there was a significant difference in performance under the different background sounds again

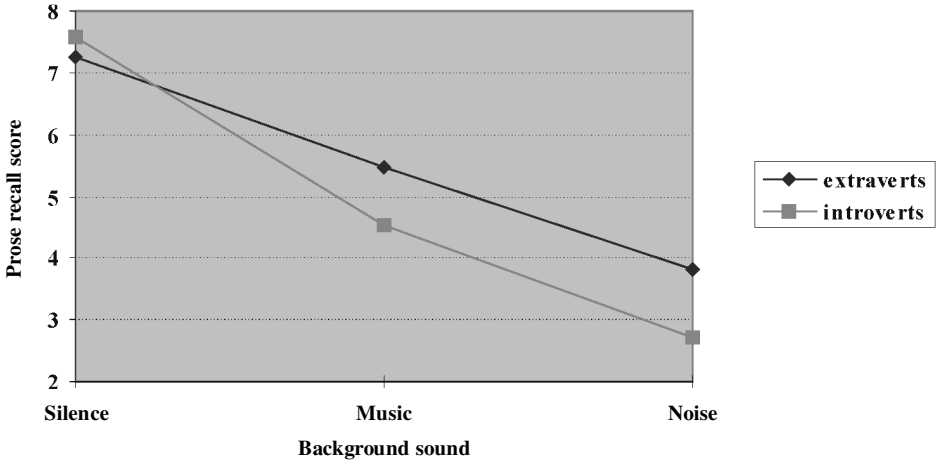

Figure 2. Mean scores of introvert's and extravert's performance on the prose recall task, in the presence of background music, noise and silence.

confirming the first hypothesis. There was no significant interaction between the personality dimensions and background sound dimensions ($F(2,70) = 0.36$, n.s.) indicating that the two main effects were not differential across conditions.

Independent t-tests were carried out to examine where the main effects for background sounds were. Results indicated that performance was significantly worse under the music condition when compared to silence ($t(52) = 2.49$, $p < 0.02$ ($p = 0.016$)). Employing the Bonferroni method to control for the familywise error rate the results remain significant. There was no significant difference in performance when comparing performance under the music condition with that in the noise condition ($t(50) = 1.86$, n.s.). Thus performance was worse in the presence of music and noise than compared to silence but performance did not differ significantly under the music and noise conditions.

3.3. *Mental arithmetic*

The results are shown graphically in figure 3.

In order to control for these gender differences a 2×3 between-subjects ANOVA was employed. Results showed no main effect for introversion/extraversion ($F(1,69) = 0.80$, n.s.) indicating that there was not a significant difference in the performance of introverts and extraverts. There was no main effect for background sound ($F(2,69) = 3.11$, n.s.) indicating that there was no significant difference in performance under the different background sounds. There was no significant interaction between the personality dimensions and background sound dimensions ($F(2,69) = 0.47$, n.s.) indicating that the two main effects were not differential across conditions.

3.4. *Post-test questionnaire*

Pearson's product moment correlations were conducted in order to examine whether there was a relationship between extraversion and ratings on the post-test questionnaires. There was a significant positive correlation between an individual's extraversion score and how likely they were to report usually studying with music in the background ($r = 0.24$, $p < 0.05$), indicating that the more extraverted an individual was the more likely they were to report studying with music There was no significant correlation between an individual's extraversion score and how likely they were to report studying with noise in the background ($r = 0.06$, n.s). There was a significant negative correlation between an individual's extraversion score and how

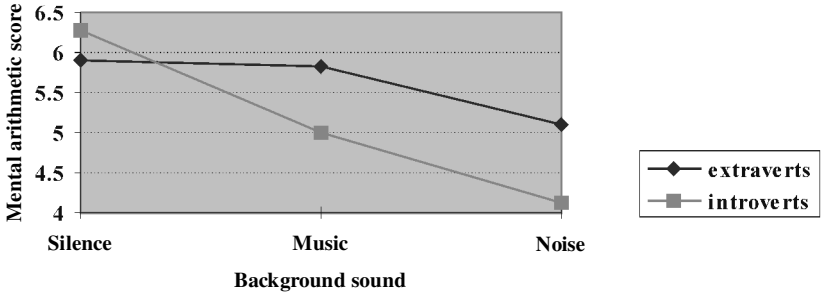

Figure 3. Mean scores of introvert's and extravert's performance on a mental arithmetic task, in the presence of background music, noise and silence.

likely they were to report finding the music distracting throughout the experiment ($r = 0.33$, $p < 0.01$) and also how likely they were to report finding the noise distracting throughout the study ($r = 0.31$, $p < 0.01$), thus the more extraverted an individual the less distracted they reported being. The music distraction self-rating and the frequency of study in the presence of music were not correlated ($r = 0.21$, n.s.), indicating that those who found the music more distracting in the study were not less likely to choose to work with it playing. Similarly there was no correlation between the noise distraction self-rating and the frequency of study in the presence of noise ($r = 0.15$, n.s.).

Correlations were also employed to examine whether there was a relationship between an individual's self-rating of how distracting they found the background sound and their actual performance on each of the tasks under those background sound conditions. None of the correlations were significant.

4. Discussion

The results of this study indicate that, on only one of the three tasks, introverts' performance is significantly lower than extraverts' performance in the presence of background music and noise but not in silence. This result is consistent with previous findings that found a differential performance of introverts and extraverts in the presence of background music, for example, Daoussis and McKelvie (1986) and Furnham and Bradley (1997).

It was also predicted that there would be a main effect for background sound. That is, overall performance would be better in silence than in background music and office noise. Results indicated that for the reading comprehension task and prose recall task, this was indeed the case. Although there was a trend for this effect in the mental arithmetic task, the results were not significant. Further, analyses for both tasks indicated that background music and noise significantly worsened performance when compared to silence, as predicted. However, music and noise were not significantly different from one another. This may be because the complexity of the music was close to the complexity of the noise. However, there was a non-significant trend for worse performance in the presence of background noise when compared to music.

Previous research has consistently indicated the detrimental effect of noise on individual's performance on complex cognitive tasks (Banbury and Berry 1998). There has been less unequivocal research on the negative effects of music on complex task performance. For example, Furnham and Bradley (1997) indicated a main effect for background sound on an immediate recall memory task but not on a reading comprehension task. Smith (1961) found no beneficial or detrimental effect of background music on tasks requiring complex cognitive activity. The discrepancy in the results of different experiments may be because of differences in the complexity of the music. However, Furnham and Allass (1999) found no effect on the cognitive performance when using silence, simple and complex music.

Noise and music may have equally distracting effects but cause quite different affective reactions. Music that is most distracting is fast, familiar, vocal music usually that is often known by, chosen and liked by the listener (Furnham and Allass 1999). Indeed it is often chosen to be distracting or to have a beneficial effect on mood. Noise that is distracting is nearly always annoying because it is unpredictable and uncontrollable and interferes with an important task (Sailer and Hassenzahl 2000). Presumably no one chooses to work in the presence of noise, although they do so in

the presence of music. The mood that results from the music and noise may in fact have specific consequences on task performance over time. While it may be that music facilitates and noise inhibits performance on tedious, mundane tasks they have equally deleterious effects on complex cognitive tasks.

This study examined the extent to which extraversion influences complex cognitive performance in the presence of background music and noise. It was predicted that introverts' performance would be worse than extraverts' in the presence of background sound, that is both music and noise on all three tasks. However, as highlighted earlier, there was a significant interaction on the reading comprehension task only. It is worth noting that there is a trend for worsened performance of introverts in the presence of music and noise (figures 1, 2 and 3); however, this was not statistically significant. The results for the reading comprehension task do support previous findings that found a significant difference between introverts' and extraverts' performance in the presence of background music. For example, Furnham and Bradley (1997) also found that introverts were more negatively affected by music in a reading comprehension task and a delayed memory recall task. Furnham and Allass (1999) found a significant interaction also on a memory task and observation task. Thus this study supports previous research and also confirms the Eysenckian hypothesis that introverts have a lower level of optimum cortical arousal than extraverts, which in turn affects their performance in the presence of background music.

This study also provides systematic evidence for the fact that introverts are also more negatively affected by background noise. Although an early experiment by Binaschi and Pelfini (1966) confirmed this result on a visual and auditory reaction task, this type of background sound had been neglected in this research area. This study therefore provides evidence for the worsened performance of introverts compared to extraverts in the presence of background noise on a *complex cognitive task,* namely reading comprehension. This also adds support to the Eysenckian hypothesis of the difference in optimum levels of cortical arousal in introverts and extraverts.

What are the possible explanations for why only the reading comprehension task obtained significant results? It could be argued that the reading comprehension task used in this study was more cognitively complex than either the prose recall or the mental arithmetic task. Research has indicated that there may only be a negative effect of background music and noise on complex tasks (Smith 1961, Evans and Johnson 2000). Thus, if the tasks were not complex enough then this may not have had enough effect to exceed introverts beyond their optimum functioning level and thus produce a differential distraction of background music and noise on the cognitive test performance of introverts and extraverts. Why could reading comprehension be more complex than prose recall and mental arithmetic? This would require one to mentally refer back to the passage while using judgement skills. However, in the mental arithmetic task, one is simply adding and subtracting numbers and in the prose recall task the main process occurring is the mental rehearsal of the words. It is worth noting, however, that there was still a trend for a more negative performance of introverts than extraverts on these tasks in the presence of background sound and noise.

It may be that with more statistical power arising from more participants a significant result may have been obtained. In addition, in this study, a median split was used to assign subjects to introvert and extravert categories, which

means that high scoring introverts may behave similarly to low scoring extraverts, this may have increased the noise in the data. The data were re-analysed for 'extreme-groups' and here all interactions were significant; however, the cell sizes were very small.

This study also examined the study habits and distraction levels of the participants. The results obtained from the post-test questionnaire would seem to suggest that the more extraverted an individual the more likely they are to choose to study with music in the background. This supports previous research, for example, Campbell and Hawley (1982) who found that introverts were more likely to study in a quiet place in a library whereas extraverts were less likely to place themselves away from the bustle. This study did not, however, find that extraverts were more likely to study in noisy places. However, it could be argued that few people are likely to admit to studying with noise in the background. Similarly, the more extraverted an individual the less likely they were to report finding the music and noise distracting. This can also be attributed to the Eysenckian hypothesis of the difference in optimum levels of cortical arousal in introverts and extraverts. This study found no correlation between a subject's self-rating of how distracting they found the background sound and actual performance. This suggests that it is unlikely that preference for background sound is influencing performance. Rather because distracting levels correlated with extraversion, it would appear that it is this that influenced performance.

This study did not find a correlation between the music and noise distraction self-rating and the frequency of study in the presence of noise and music. This may suggest that listening to music and being in the presence of noise does not result in a tolerance to music and noise that could reduce distraction levels in this study. It could also be argued that the reason for the differences in the different performance of introverts and extraverts was not simply due to the fact that introverts, who were less likely to listen to music and noise, had less of a tolerance to music and noise (due to previous experience) and thus had worsened performance.

The findings of this study can be applied to educational and work settings and they highlight how individuals can optimize their work performance. It also has implications for work settings that may not be ideal, i.e. very noisy settings, and highlights which individuals may be less negatively affected by these conditions. The results can be applied to many settings.

In conclusion, the results obtained from this research indicates the negative performance of both music and noise on task performance. This study does support other research which has found a negative effect of noise on complex task performance (Banbury and Berry 1997). More importantly, this study supports the experimental hypothesis that, on the reading comprehension task, introverts are more negatively affected by music than extraverts. It also provides evidence of the fact that introverts are also more negatively affected by noise, which lends further support for the Eysenckian hypothesis. Clearly the replicability of the findings depends on the nature of the task and the nature of the distracter as well as the personality of the participants. While these results suggest that music and noise are not significantly different in their distracting effects on complex cognitive tasks, the results would no doubt be different for simpler tasks where music may seem beneficial and noise not, depending also on whether the individual has control over, or choice of, the distracter.

References

Banbury, S. and Berry, D. C. 1998, Disruption of office-related tasks by speech and office noise, *British Journal of Psychology*, **89,** 499 – 517.

Belojevic, G., Slepcevic, V. and Jakovljevic, B. 2001, Mental performance in noise: the role of introversion, *Journal of Environmental Psychology*, **21,** 209 – 213.

Binaschi, S. and Pelfini, C. 1966, The effects of noise on reaction times: the relationship between efficiency and personality, *Bollettino di Psicologica Applicata*, **67 – 68**, 51 – 58.

Campbell, J. B. and Hawley, C. W. 1982, Study habits and Eysenck's theory of Extraversion-Introversion, *Journal of Research in Personality*, **16,** 139 – 146.

Cantril, H. and Allport, G. W. 1935, *The Psychology of Radio* (New York: Harper).

Daoussis, L. and Mckelvie, S. J. 1986, Musical preferences and effects of music on a reading comprehension task for extraverts and introverts, *Perceptual and Motor Skills*, **62,** 283 – 289.

Evans, G. W. and Johnson, D. 2000, Stress and open-office noise, *Journal of Applied Psychology*, **85,** 779 – 783.

Eysenck, H. J. and Eysenck, S. B. G. 1975, *Handbook for the Eysenck Personality Questionnaire* (London: Hodder & Stoughton).

Eysenck, M. W. 1981, Learning, memory and personality, in H. Eysenck (ed.), *A Model for Personality* (Heidelberg: Springer Verlag), 169 – 207.

Fogelson, S. 1973, Music as a distracter on reading-test performance of eighth grade students, *Perceptual and Motor Skills*, **36,** 1265 – 1266.

Furnham, A. 2001, Person-organisation-outcome fit, in B. Roberts and R. Hogan (eds), *Personality and Individual Differences in the Work Place* (Washington, DC: APA), 223 – 251.

Furnham, A. and Allass, K. 1999, The influence of musical distraction of varying complexity on the cognitive performance of extraverts and introverts, *European Journal of Personality*, **13,** 27 – 38.

Furnham, A. and Bradley, A. 1997, Music while you work: the differential distraction of background music on the cognitive test performance of introverts and extraverts, *Applied Cognitive Psychology*, **11,** 445 – 455.

Furnham, A., Gunter, B. and Peterson, E. 1994, Television distraction and the performance of introverts and extraverts, *Applied Cognitive Psychology*, **8,** 705 – 711.

Furnham, A., Trew, S. and Sneade, I. 1999, The distracting effects of vocal and instrumental music on the cognitive test performance of introverts and extraverts, *Personality and Individual Differences*, **27,** 381 – 392.

Hargreaves, D. J. and North, A. C. (eds) 1997, *The Social Psychology of Music* (Oxford: Oxford University Press).

Kiger, D. M. 1989, Effects of music information load on a reading comprehension task, *Perceptual and Motor Skills*, **69,** 531 – 534.

Kirkpatrick, F. H. 1943, Music takes the mind away, *Personnel Journal*, **22,** 225 – 228.

Kjellberg, A., Landstorm, U., Tesarz, M., Soderberg, L. and Akerlund, E. 1996, The effects of non-physical noise characteristics, ongoing task and noise sensitivity on annoyance and distraction due to noise at work, *Journal of Environmental Psychology*, **16,** 123 – 126.

Konz, S. A. 1962, The effects of background music on productivity of four monotonous tasks. *Dissertation Abstracts*, 650083.

McGehee, W. and Gardner, J. 1949, Music in a complex industrial job, *Personnel Psychology*, **2,** 405 – 417.

Morgenstern, F. S., Hodgson, R..J. and Law, L. 1974, Work efficiency and personality. A comparison with introverted and extraverted subjects exposed to conditions of distraction and distortion of stimulus in a learning task, *Ergonomics*, **17,** 211 – 220.

Oldham, G. R., Cummings, A., Mischel, L. J., Schmidtke, J. M. and Zhou, J. 1995, Listen while you work? Quasi-experimental relations between personal-stereo headset use and employee work responses, *Journal of Applied Psychology*, **80,** 547 – 564.

Rauscher, F. H., Shaw, G. L. and KY, K. N. 1993, Music and spatial task-performance, *Nature*, **365,** 611 – 611.

Sailer U. and Hassenzahl, M. 2000, Assessing noise annoyance: an improvement-oriented approach, *Ergonomics*, **43,** 1920 – 1938.

Saville, P. and Oldsworth, R. (eds) 1993, *SHL Practice Tests, Series 2* (Esher: Saville and Holdsworth).

Smith, W. A. 1961, Effects of industrial music in a work situation requiring complex mental activity, *Psychological Reports*, **8,** 159–162.

Stelmach, R. 1981, The psychophysiology of extraversion and neuroticism, in H. J. Eysenck (ed.), *A Model for Personality* (Berlin: Springer), 38–64.

Uhrbrock, R. S. 1961, Music on the job: its influence on worker morale and production, *Personnel Psychology*, **14,** 9–38.

Weinstein, N. D. 1978, Individual differences in reaction to noise: a longitudinal study in a college dormitory, *Journal of Applied Psychology*, **63,** 458–466.

Williams, T. B. 1961, A study of the effects of music as a distracter on the mental test performance of certain eleventh grade students, *Dissertation Abstracts*, **22,** 168.