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The distracting effects of vocal and instrumental music on the cognitive test performance of introverts and extraverts

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Abstract

This study examined the effects of vocal and instrumental music upon the performance of introverts and extraverts on three cognitive tasks. In the presence of either vocal or instrumental music, or in silence, introverts and extraverts sixth form pupils ($N=144$) completed a reading comprehension, a logic problem and a coding task. An interaction was predicted such that instrumental music would impair and enhance the test performance of introverts and extraverts, respectively, and that these effects would be magnified in the vocal music condition. No significant interactions were found, although there was a trend for the introverts to be impaired by the introduction of music to the environment and extraverts to be enhanced by it, particularly on the reading and coding tasks. A main effect of extraversion was found in the reading comprehension task and nearly in the coding task ($p<0.06$). There was a condition effect on the logic task with subjects doing best in the presence of instrumental music. Experimental explanations for the lack of predicted interactions are offered. These findings are discussed with respect to Eysenck's theory of personality [Eysenck, H. (1967). *The biological basis of personality*. Springfield, IL: Thomas.].

1. Introduction

The effect that music can have upon moods, cognition and behaviour has been an area of interest to both applied and cognitive psychologists since the turn of the century (Cantril & Allport, 1935; Fox, 1971; Fogelson, 1973; Milliman, 1986) and personality researchers (Daoussis & McKelvie, 1986; Furnham & Bradley, 1997; Furnham & Allass, in press). Investigating the exact nature of the effect that music may have upon performance is more relevant than ever, as music has been found to have an influence on consumer behaviour. For example, Milliman (1982) found that playing slow (<73 bpm) music in a supermarket caused customers to walk more slowly and spend more money than when faster (>93 bpm) music was played. Further, music is frequently heard in

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the workplace, from factory floors to offices, accompanying tasks requiring varying levels of skill and concentration (Henderson, Crews & Barlow, 1945; Smith, 1961; Fox & Embrey, 1972).

Advances in technology have meant that being able to listen to music at home is an affordable option for most individuals and the invention of portable radios and cassette and CD players has meant that music can be readily available to the individual in any setting at any time. Thus, music may now frequently accompany studying and the question of how it may affect comprehension and learning is an important practical issue. Cantril and Allport reported in 1935 that the majority of students, 68%, studied whilst listening to their radios and it is quite likely, given the increased availability of music and the relatively low cost of equipment to play it on, that today this percentage would be much greater.

Playing music in the workplace is a tradition dating back to at least the turn of the century, where music was used primarily in an attempt to lift spirits and relieve tedium and boredom. Early research into the effects of music in the workplace suggested that 'easy listening' (which was sometimes termed 'industrial music') was most appropriate for routine activities (McGehee & Gardner, 1949), as it helped to relieve tension and boredom associated with these types of tasks. Smith (1961) found evidence for this in the attitudes of key-punch operators listening to music during break periods between complex mental activities. It was shown that attitudes to the music were universally positive; all subjects wanted the music to be a permanent feature in their office and 90% said they were happier when the music was playing. However, the music had no significant effect on task performance. Early research thus indicated that whilst music induced positive attitudes towards work and improved mood, it did not seem to have any noticeable effects on productivity or performance (Smith, 1961). This has been supported by a more recent study by Perrewe and Mizerski (1987) who saw that music had no effect on how subjects perceived tasks, be they complex or simple.

However, there have been inconsistencies in the results of studies looking into the effects of music on task performance as opposed to perception. In a review of the research completed in this area, Uhrbrock (1961) noted that factory workers preferred to work where music was played rather than where it was not played, but also that not all workers liked music while they worked, with between 1 and 10% of them being annoyed by it. Further, music can have adverse effects on the output of individual employees (Furnham & Bradley, 1997).

Investigations into the effects of music on performance have focused mainly upon different musical styles (Sogin, 1988) or characteristics of the music such as volume (Wolfe, 1983) or complexity (Furnham & Allass, in press) and have produced mixed results. Fogelson (1973) saw that popular instrumental music significantly reduced scores on a reading comprehension test and this was an effect also seen in a study by Williams (1961). Williams (1961) also found that classical music had no effect on performance, unlike Rauscher, Shaw and Ky (1993), who found that listening to Mozart resulted in a significant improvement in spatial I.Q. scores. Some researchers, such as Sogin (1988), have failed to show any significant effect of music (in this case, jazz, pop and classical) on task performance, while Furnham and Bradley (1997) have shown that pop music can significantly impair task performance.

Furnham and Allass (in press) looked at the effects of complex and simple music, as rated on factors such as tempo, repetition, melodic complexity and instrumental layering and saw that there was no significant effect of musical complexity on performance. However, in a similar vein, Kiger (1989), found that scores in a reading comprehension test were significantly higher in a 'low

information-load music' condition than either a silent condition or a 'high information-load music' condition, where 'information-load' was measured by tonal range, repetition and rhythmic complexity. The present studies aim to look at the effect of vocal and instrumental music when compared to silence. Vocals contribute to the complexity and information load of the music and there are few studies which have looked at their effects. This study also takes into account the personality types of the individual subjects, namely their level of arousal.

The conflicting results seen in these studies could be due, at least in part, to the types of tasks used to assess performance. The most frequently employed tasks appear to be reading comprehension tests (Freeburne & Fleischer, 1952; Kiger, 1989) and tests of short term memory (Belsham & Harman, 1977; Salamé & Baddeley, 1990; Vitulli & McNeil, 1990; Furnham & Allass, in press), and others have included the Stroop test (Houston & Jones, 1967; Parente, 1976) and motor tasks (Kjellberg & Sköldström, 1991). Strong evidence for the type of task having an influence on the capacity of music to distract comes from a study by Konz (1962), who saw that letter-matching task scores were significantly negatively improved by the presence of music, whereas scores on a manual assembly task were not significantly affected by the same music. Similarly, Furnham and Bradley (1997) found that reading comprehension scores were significantly affected by the presence of pop music, yet this music had no significant effect on scores on immediate and delayed free recall memory tests. This implies that the characteristics of the particular task may play an important role in the effect that the music has on performance. For this present study, a reading comprehension, a logic problem and a coding task have been chosen as the experimental tasks. The reading comprehension and the logic problem were chosen as they require skills which are also needed in academic homework, e.g. clear logical thinking, language comprehension and interpretation. The coding task, requiring good hand-eye co-ordination, was chosen as a contrast to the other tasks.

In his review into the effects of music at work, Uhrbrock (1961) acknowledged that music has an arousing effect on individuals. He noted that feelings of euphoria can be experienced during periods of musical stimulation and that these have a physiological basis, where there is an increase in blood pressure in some individuals in response to music. As it had been shown that carrying out repetitive tasks, such as assembly work, leads to a drop off in arousal and attention, and hence efficiency, after a relatively short period (Murrell, 1962), Fox and Embrey (1972) hypothesised that introducing music at the end of the active period for the task would result in sustained arousal. When the natural arousal caused by the task had dropped-off, then music would act as an arousing stimulus and would maintain arousal levels, ultimately leading to sustained efficiency. Indeed, it was found that workers checking metal parts for defects who were exposed to music after a period of time did detect significantly more faults than those who did not hear any music.

Despite the recognition of the potential for auditory stimulation to affect arousal levels in the individual, there has been little appreciation of individual differences in optimum levels of arousal. The Eysenck (1967) theory of personality holds individual variation in cortical arousal as its central issue. His theory describes and explains the differences between introverts and extraverts in terms of internal arousal. He argues that introverted individuals have a lower optimum cortical arousal level than extraverted individuals, whose optimum arousal level is high. Therefore, introverts and extraverts differ in the amount of externally derived stimulation that they require to reach their optimum point of arousal. Due to their lower neurological threshold of arousal, introverts do not need as much external stimulation to reach their optimum level of functioning and so are satisfied

at much lower intensities of stimulation. If they are subjected to stimulation which pushes them over their optimum functioning threshold, introverts experience an inhibition of excitation and become aversive to the over-stimulating environment; their performance on a task will deteriorate. Those individuals classified as extraverts need more external stimulation to reach their optimum functioning level and this encourages them actively to seek out stimulation in the environment. The Eysenck (1967) theory of personality is similar in many respects to Vermolayeva–Yomina's (1964) concept of weak (introvert) and strong (extravert) nervous systems, the weak system being characterised by high cortical arousal and the strong system by low cortical arousal. Campbell and Hawley (1982) saw evidence of this stimulation-seeking behaviour in extraverts and stimulation-avoidance in introverts in an investigation looking at the study habits of these two personality types in a library. It was found that introverts were significantly more likely to choose to study in a quiet area of the library away from noise and activity, whereas extraverts consciously sought out busier study areas which provided the opportunity for social interaction. Further, introverts and extraverts have been shown to differ in their habits when it comes to studying to music, with extraverts choosing to listen to music whilst studying on more occasions than introverts (Furnham & Bradley, 1997) and extraverts reporting to study twice as much (50% of the time) as introverts (25% of the time) in the presence of music (Daoussis & McKelvie, 1986).

There have been various studies which report differences between the performance of introverts and extraverts when faced with a distracter. Furnham, Gunter, and Peterson (1994) examined the distracting effects of television on cognitive processing. Subjects completed two reading comprehension tasks, one in silence and one in the presence of an operating television. As predicted, it was found that there was a significant interaction between personality type and condition; the extraverts and introverts both performed better in silence, but the extraverts performed better than the introverts in the presence of television distraction. This result was attributed to the television drawing on cognitive resources required for the reading comprehension. Morgenstern, Hodgson, and Law (1974) found that extraverts tended to perform better in the presence of a distracter than in silence, whereas introverts functioned less efficiently in its presence. Subjects were required to attend to and remember specific words from a list read to them, either in silence or whilst being distracted by German or English words, or distortions of these. The detrimental effects of distraction on short-term memory varied as a function of extraversion, where the most extraverted subjects remembered more words when distractions were present than when in silence. The most introverted individuals, however, remembered fewer words whilst being distracted. Other studies have looked at music as the distracter. Furnham and Bradley (1997) also found that, in the presence of pop music songs separated by a male voice, scores on a reading comprehension test and scores on a delayed recall short-term memory test were significantly reduced for introverts and significantly increased for extraverts. In an investigation into the effects of complex and simple music (as rated on factors such as instrumental layering and tonal complexity) in comparison to silence, Furnham and Allass (in press) found that there was a marked (yet non-significant) trend for the performance of introverts to deteriorate with music, and for this performance to deteriorate further as the complexity of the music increased. Extraverts, on the other hand, showed improvement in performance as the complexity of the music increased, with the most superior performance being seen in the complex music condition. These studies provide support for Eysenck's theory of personality.

This study therefore hypothesises that extraverts will be positively and introverts will be nega-

tively affected by the instrumental music in the environment in which they are working, and that when vocals are added, these (deleterious) effects will be amplified. It is also hypothesised that there will be no difference between scores for the two personality types in silence. There is evidence from a number of studies that vocals are particularly distracting (Belsham & Harman, 1977). Salamé and Baddeley (1989) found a clear effect of irrelevant speech on immediate serial recall of visually presented digits, where irrelevant speech significantly increased the amount of errors made by the subjects. Jones, Miles and Page (1990) also looked into the effects of irrelevant speech and showed that its deleterious effects were dependent on the speech being meaningful. It is logical to say that this effect could equally apply to lyrics in songs. The presence of vocals in a piece of music should mean that the information-load of the music is greater than an identical piece without vocals (Kiger, 1989). Therefore, introverts should find vocal music even more distracting than instrumental music, when compared to silence, as it is more arousing. Extraverts, on the other hand, should benefit from the stimulation induced by both types of music, and their performance should be greatest for the condition offering the most arousal, i.e. the vocal music condition. Further, the nature of the task completed in the presence of distraction is relevant. The more involving the task and mental processing required, the greater the effect of distracting music. Hence it was predicted that there would be a significant interaction (personality $\times$ condition) for the reading comprehensions, but not the coding.

2. Method

2.1. Participants

142 sixth form students from two British secondary schools took part in the experiment. The ages of the subjects ranged from 16 to 18 years (mean age = 16.91 years); 111 were male and 31 female. All subjects reported their first language to be English.

2.2. Materials

The subjects initially completed the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) in silence, to assess their level of extraversion. The subjects also completed three tasks, in the presence of either vocal music, instrumental music or in silence. The musical tracks that were chosen were instrumental versions and vocal versions of the same tracks; the background to the vocal version being identical to the instrumental version. Tracks with these two types of versions were deliberately chosen so that any differences between responses to them could be attributable to the vocals. The tracks chosen were (in this fixed order): "Shine" by Monaco (72 bpm); "Papa was a Rolling Stone" by Was Not Was (114 bpm); "Change the World" by Eric Clapton (50 bpm) and "What Do You Want From Me?" by Monaco (74 bpm). The mean tempo of these tracks was 77.5 bpm. Retrospectively, it would have been preferable to pretest the music for arousal on a group of introverts and extraverts to assure its appropriateness in this study. The participants were given three tests. One was a reading comprehension test taken from the GMAT (graduate admission tests) (Martison, 1992) range of tests and was intended to tap in on skills associated with academic study, i.e. comprehension and accurate question answering. This consisted of a 400 word passage,

followed by six multiple choice questions, each with five options. The participants were given 10 min to complete this test and scored 2 points for each correct answer. This was the same reading comprehension test used in the studies by Furnham and Bradley (1997) and Furnham and Allass (in press). A second test was a logic problem taken from the LSAT (Law School Admission Test) (White, 1997) range of tests and this required logical deduction, clear thinking and good analytical skills. This consisted of a 90 word paragraph describing a physical situation, containing 3 rules, followed by six multiple choice questions, each of five options, where only the correct answer could satisfy the rules stated. Subjects were given 9 min to complete this test and scored 2 points for every correct answer. The remaining test was a coding task, as used by Sogin (1988). The test comprised of 370 hand/eye co-ordination problems spanning three pages. Subjects were given a key on each page showing a random set of musical notes with corresponding numbers from 0 to 9. Subjects were required to write the symbol corresponding to the given 370 numbers into boxes containing only the numbers. Subjects were given 8 min to complete as many boxes as possible and scored 1 point for every correct box completed. Stopwatches were used to time the tests accurately.

2.3. Procedure

The subjects were randomly assigned to three test rooms. Each room of subjects completed the tests in different orders and experienced the background noise conditions in different orders. This was so that ultimately, each test was experienced either first, second or third by one third of the total sample group and that each noise condition was experienced first second or third by a third of the group also.

Each test room was assigned an invigilator to run the session. The subjects were told that the experiment was confidential and that they could cease participation at any time. At the beginning of each test session, all subjects were given the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) to complete in silence and were given as much time as needed to do this in, which was about 5 min. Subjects were then required to fill in a pre-test questionnaire, which requested personal details and information about their current level of motivation. Subjects then completed the three tests under the three background noise conditions, the order and combination of which depended on the group in which they were in. The music was played at a constant, moderately loud level, through the use of a stereo positioned at the front of each classroom. The tests were completed with a minimal pause between each and were timed using a stopwatch. On completing the tests, subjects were asked to rate on a 10 point scale how distracting they found the different types of music, and to indicate on a 7 point scale increasing in 15% intervals, the percentage of time that they study in the presence of music. The subjects were then debriefed, and thanked for their participation. The session length was approximately 35 min.

3. Results

The data from the two schools was run separately and then combined. The first school had almost equal numbers of males and females, while the second was all male. There was no difference between the data sets and no more sex difference effects than may be expected by chance.

The subjects were classified as either introverted or extraverted on the basis of a median split of their scores on the Eysenck Personality Questionnaire. The median score was 16.5 and so 'introverts' were those scoring 16 or less ($n=71$, mean EPQ score of group = 11.0) and 'extraverts' were those scoring 17 or more ($n=71$, mean EPQ score of group = 18.5). The terms 'introvert' and 'extravert' are more suited to describing subjects chosen from extremes of the distribution of EPQ scores, but for convenience they will be used here. The mean EPQ score for the subjects was 14.5, which is slightly higher than that expected for a random sample, which is usually 12 or 13.

Three scores from the coding task, two scores from the reading comprehension and one score from the logic problem were dropped. This was due to them being either unusually low or unusually high. If they were very low, it was implied that the subject did not feel sufficiently motivated to complete the task to the best of their ability.

Table 1 shows the means and standard deviations for introverts and extraverts in silent, instrumental and vocal conditions, for each of the three tests, where $N=142$.

The data from each of the three tasks was analysed separately using 2 (introversion/extraversion) × 3 (vocal/instrumental/silent) between groups ANOVAs. For the reading comprehension, there was a main effect of extraversion ($F(1, 198)=4.09$, $p<0.05$), no main effect of condition ($F(2, 138)=0.15$, ns) and no significant interaction between them ($F(2, 138)=2.80$, $p<0.06$). For the logic problem there was nearly a main effect of extraversion ($F(1, 138)=3.33$, $p<0.07$), a marginally significant effect for condition ($F(2, 138)=3.14$, $p<0.05$) and there was no interaction ($F(2, 138)=0.13$, ns). Likewise in the coding task, there was no main effect of extraversion ($F(1, 138)=0.13$, ns) or condition ($F(2, 138)=0.36$, ns) and no interaction ($F(2, 138)=0.92$, ns).

Due to the apparent trend in the data, further ANOVAs were carried out on the data yielded by subjects in the top and bottom thirds ($N=85$) and quarters of the EPQ score range, in the hope of improving the chances of finding significant main effects or interactions. However, the pattern of the data did not change and none of the hypothesised interactions were significant.

Table 1

		Introvert			Extravert		
		Silence	Instrumental	Vocal	Silence	Instrumental	Vocal
Reading	mean	8.00	7.48	8.53	7.56	7.62	6.75
	S.D.	1.91	1.62	2.09	1.89	1.96	2.35
	n	25	23	19	18	26	28
Logic	mean	6.00	7.00	7.47	5.33	6.72	6.07
	S.D.	2.16	2.89	2.89	2.17	2.23	2.51
	n	25	24	19	18	25	27
Coding	mean	247.08	237.42	227.16	228.72	228.31	238.32
	S.D.	50.08	53.35	54.48	44.28	60.95	47.62
	n	25	24	19	18	26	28

A Pearson's correlation revealed that there was a significant correlation between scores on the EPQ and the frequency with which the individuals reported to listen to music whilst studying, $r=0.44$, $p<0.01$. Frequency of music listening increased as scores showed increased high extraversion. An independent t-test showed that there was a significant difference between introverts and extraverts with respect to how often they listen to music whilst working, $t=2.48$, $p<0.02$, which indicates that extraverts listen to music more often than introverts. Further, self-rating of how distracting they found the vocal and instrumental music, there were differences between the two personality types. A related samples t-test showed that for introverts, there was a significant difference between their ratings for the two types of music, $t=2.38$, $p<0.025$, with vocal music being rated as more distracting. The extraverts however, did not rate the vocal and instrumental music as being significantly different in terms of its capacity to distract. Independent t-tests showed that introverts and extraverts did not give distraction ratings for the vocal music which were significantly different and this was also true for the instrumental music. Overall, 91.02% of the subjects reported that they listened to music whilst they studied.

3.1. Discussion

The aim of this experiment was to explore the effects that vocal and instrumental music have upon the performance of introverts and extraverts on three different tests and to silence. For the sample of 142 pupils, it was seen that there were few significant main effects of background noise condition upon test performance, meaning that the music neither significantly enhanced nor significantly impaired test scores of the subjects beyond those achieved in silence. There was an interesting condition effect in the logic task. This finding supports the previous findings of Smith (1961) and of Sogin (1988), who both found that musical stimulation had only a marginal effect on task performance. The results yielded a few significant main effects of personality. There was one significant and one near significant ($p<0.07$) effect. In both instances, extraverts did better than introverts, which may be the result of group testing. This finding supports the work of Furnham et al. (1994), Furnham and Bradley (1997) and Furnham and Allass (in press), who similarly found personality to have few significant effects on test performance. However, the data from the three tests showed that there were no significant interactions between personality and background noise condition, as predicted. Previously, the reading comprehension task used in this study has produced significant interactions between the dimension of introversion/extraversion and background noise (Furnham & Bradley, 1997), but this effect was not fully replicated in this present study, though the interaction was very nearly significant ($p<0.06$). Further, this result does not lend support to the Eysenck (1967) theory of personality.

Despite the lack of significance on the statistical analysis of the test scores, it can be seen from Table 1 that there is an apparent trend in the data which supports the Eysenck (1967) theory. The performance of the introverts on the reading tests is consistently impaired by the introduction of music into the experimental setting, and conversely, the performance of the extraverts is enhanced by the music. On the reading comprehension, introverts' performance was impaired further by the addition of vocals to the background music and for extraverts, their performance was improved by this factor. This effect, although not significant, appears to support Eysenck's theory of personality; the music is an arousing stimulus and has increased arousal levels in the subjects. For the introverts, this arousing stimulus has pushed them over their optimal arousal level for

performance, leading to a deterioration in tests scores and conversely for the extraverts, the arousal caused by the music has moved them closer towards their optimal arousal level which has led to an improvement in their performance.

It was thought that the addition of vocals to the music would amplify the effects on performance produced by the instrumental music. This was the case for the introverts completing the coding difference, where their performance declined slightly by the addition of vocals, but there was a mixed pattern between types of music for the other two tasks. On the other hand, on the coding test, extraverts performed better with vocal compared to instrumental music, but on the other two tests, scores in the vocal music group were lower than in the instrumental group. It was anticipated that scores in the instrumental and vocal conditions could be explained in terms of the arousal produced by the two music types. The instrumental music may have increased arousal levels in the introverts and the extraverts to the extent that their performance on the tests was impaired and enhanced respectively. The added vocals may not have increased the music's capacity to arouse to any great extent, as expected, and so this could explain why performance on the tests carried out in the presence of instrumental music was not very different to that on the tests completed in the vocal music condition. The test performance of the introverts in the instrumental and vocal conditions did not reflect their opinions of these music types, as they reported that the vocal music was significantly more distracting than the instrumental. The post test questionnaire also revealed a positive correlation between EPQ scores and the frequency with which the individuals listened to music whilst studying, showing that the extraverts listened to music more often than the introverts. This supports the findings of Campbell and Hawley (1982) and Furnham and Bradley (1997), who found that extraverts actively seek out environments which are arousing, where the arousal takes the form of social or musical stimulation.

The lack of significant results from the ANOVA tests could be accounted for, at least partly, by the manner in which the subjects were split into 'introvert' and 'extravert' categories. This was done by means of a median split and so consequently, high scoring introverts would have behaved similarly to low scoring extraverts. This method may have greatly increased the 'noise' in this experiment. In recognition of this, further ANOVAs were carried out on the scores yielded by subjects whose EPQ scores were within the extreme thirds or quarters of the EPQ distribution. However, this did not change the results.

Clearly there are three major factors in the research: individual differences; the nature and type of the distracting stimulus (music) and the task being performed. Inconsistencies in the research results are frequently a result of not having comparable data. To demonstrate a personality $\times$ condition interaction, which is the focus of the paper, it seems one needs clear individual differences; highly distracting music (complex, familiar) and a task involving considerable attention and processing. Another relevant factor is the conditions. This study used group testing conditions.

The classrooms in which the experiment took place were not free from distraction: continuous waist-high windows formed 2 of the 4 walls of each of these rooms, through which the subjects were able to see and hear activity in the rest of the school, especially on the games field. Further, despite the subjects being randomly allocated to the testing rooms, subjects did know each other within the groups and naturally chose to sit with each other. The effects of the windows and the presence of their friends may have had the effect of arousing the subjects, and so effects on test performance would have also included the effects of the arousing environment. The extraverts would have been enhanced by the environment in all three conditions meaning that their 'silent

performance' may have been better than it should have been. Likewise for the introverts, their performance may have been impaired in all conditions, with their performance in the silent conditions been worse than it should have been had the testing environment been less distracting. Furnham et al. (1994) did individual testing using TV distraction and found a clear interaction effect.

It is also possible that other personality or individual differences factors, for example conscientiousness, need for achievement or intelligence, may come into play to various degrees in this type of experiment and they may have their own effects on performance which may interact with the background noise. Subjects were streamed for ability so it is unlikely that intelligence played a role, but other individual difference factors may have affected the outcome. The EPQ also measures the degree of neuroticism and psychoticism in the individual's personality, as well as a measure of social desirability, or how much they want to appear to be 'socially acceptable'. It may be an idea in future studies to measure these variables for each subject and to co-vary them out in the statistical analysis of the data, so that they do not contribute to any effects seen. Furnham et al. (1994) did indeed do this, but found neuroticism and lie scores had no effect on the significant interactions.

A further explanation for the lack of significant interactions between the variables of personality and background noise could be the music selected (North & Hargreaves, 1997). The choice of music was restricted by the relatively narrow range of tracks commercially available which have both instrumental and vocal versions. Tracks which were likely to be very familiar to the subjects were avoided, but the resulting tracks still would have been reasonably well known to the age group which carried out this experiment. As Hilliard and Tolin (1979) found, familiarity with a musical track leads to improved performance on tests carried out in its presence, perhaps because if it is well known then it is easier to disregard. It is likely that some of the subjects would have been more familiar with the chosen tracks than others and so this would have affected the results. Extraverts, for example, seek musical stimulation more often than introverts (Furnham & Bradley, 1997) and so they may be more likely to have come across the tracks used. To remedy this situation, in future experiments it may be wise to use novel musical stimuli, which have been produced for the sole purpose of the experiment, rather than to use widely available pre-recorded material.

On a final note, most (around 90%) of the subjects in this experiment reported that they listened to music whilst studying at home (although in future we should perhaps ask what sort of music and what sort of study tasks). This contrasts with the findings of Cantril and Allport (1935), who reported that at that time, only 68% of students listened to music when working. This lends support to the idea that being able to listen to music in the home, or indeed in any study environment, has become a more affordable and a more available option for many more people and so it is perhaps more important than ever to unravel the exact nature of effects that it can have on task performance.

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