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The effect of background and noise on the cognitive test performance of introverts and extroverts.

Siyi Koo[1], Alastair McClelland[2] & Adrian Furnham[1,3]

[1] Department of Clinical, Educational, and Health Psychology, University College London, London, UK
[2]Department of Experimental Psychology, University College London, London, UK
[3]Norwegian Business School (BI), Nydalveien, Olso, Norway

Corresponding author: a.furnham@ucl.ac.uk

Abstract

Previous research has found that the background auditory distractors (music and noise) have a more severe impact on introverts' performances on complex cognitive tasks compare to extraverts. Because most of the previous studies were conducted on Western samples, the present study extends the research literature by examining this distractive effect on Chinese participants. 93 Chinese participants carried out three cognitive tasks with the presence of Chinese pop songs, background office noise, and silence. The result suggests that the three background distractions conditions were not able to cause differences in performance on all three tasks. The performances also did not differ between extraverts and introverts. However, it was found that music had the strongest enhancing effect on participants' performances on the reading comprehension task. The results were explained in light of habituation to noisy environment among Chinese participants.

Introduction

It is common practice in the concurrent workplace to work under background sounds. Modern technologies, such as computers, printers, ventilation systems, have introduced noises into workplaces. Moreover, in recent decades, office layout has transitioned from conventional private spatial configuration to modern open-plan setting (Kim, & de Dear, 2013). This change is done in the hope to facilitate communication and interaction between co-workers, promoting workplace satisfaction and teamwork effectiveness (Brand & Smith, 2005). This trend also potentially increased the level of noise in the office, as more equipment, furniture and people are enclosed in the same room. People indeed have noticably complained about the presence and prevalence of such noise

In the case of music, while for some people, the presence of the background sound was mandatory by the company, such as working as a cashier in a fast-food restaurant, others actively put themselves into such situations. A survey established that in offices, 80% of employees listened to music at work, on average for 36% of the time (Haake 2006). The research results on the beneficial effects of background sound at workplace further encourage companies to introduce music into offices. Lesiuk (2005) found that music has a positive influence on mood. However, she also noted that the benefit comes at the cost of decreased speed and work quality. This suggests that the presence of background sounds should have some direct impact on people's performance at workplace, especially considering it often involves a various type of mental operations.

Distracting effects of background sounds

The literature begins with independent research on the distracting effect of music and noise. For both types of background sounds, the research results seem to be contradictory. In general, noises were found to have a detrimental effect on cognitive performances. In real life situations, people live in areas with a high level of aircraft noise make more everyday errors (failure of attention, memory and action) than those who live in a low noise neighbourhood (Smith & Stansfeld, 1986). Sailer and Hassenzahl (2000) found detrimental effects of noise as a source of stress on cognitive task performance in office settings. Furnham and Strbac (2002) showed that participants' performance on a reading comprehension and a prose recall task was significantly worse in the presence of office noise than in silence.

However, there has been contradicting findings as well. White noises did not seem to have disturbance effect on the performance of memory task (Salame & Baddeley, 1982), whereas noises with vocal components were found to negatively impact the performances

(Salame & Baddeley, 1989). Thus, the differences in the effect of noise seem due to the differences in the nature of the noises, such as its content and volume. On the other hand, Dornic (1975) proposed that depending on the complexity of the tasks the effect might also differ. Deep (semantic) processing, which requires the comparison of the meaning of stimuli, is more difficult and as such are more affected by noise. Physical processing, on the other hand, is much easier, and are not affected, or even facilitated by noises.

The effect of music has mostly been studied separately from noise, and its effects seem more complex. As mentioned above, earlier studies found music to have motivating effects in workers, but no impact on work outcomes (e.g. in an industrial setting, McGhee & Gardner, 1949). Similar to the proposals in the effect of noise, Smith (1961) proposed that the effect of music depends on the cognitive complexity of the tasks being conducted. When the task is routinal and undemanding, music serves to reduce tension and boredom associated with these tasks; when the task is cognitive complex, music acts as a distractor and impairs the performance. Oldham et al. (1995) noted that the presence of background music resulted in significantly positive effects on performance, satisfaction, and mood state in the office environment, but only for simple tasks.

Nevertheless, there are other contradicting findings suggesting the nature of the tasks alone cannot explain the differential effects of music. Furnham (2001) noted that vocal music was significantly more distractive than purely instrumental pieces on similar tasks. It, therefore, seems that perhaps the nature of music is another contributor to the differential effect of music. It is possible that the vocal features of background noises use the resources in the working memory system and causes disturbances in performance (Baddeley, Eysenck, & Anderson, 2009). If this is the case, tasks involve linguistic components should be most strongly affected, as not only the central executive but also the phonological loop of the working memory system is occupied by the irrelevant phonological information from the background noises. Crawford and Strapp (1994) found that vocal music interfered with the performance on a linguistic reasoning task but not on a maze-scanning task. On the contrary, Furnham and Bradley (1997) did not find an adverse effect of background music on a reading comprehension task. As the finding suggests, working memory account do not seem to be sufficient to explain the variances in the distractive effect of music.

On another dimension, Thompson Schellenberg & Husain (2001) proposed the arousal and mood hypothesis that music affect cognitive abilities through changing the listeners' arousal. Music tempo was identified to be associated primarily with arousal, while musical mode was a predictor of mood (Husain Thompson & Schellenberg, 2002). This hypothesis is best supported by the Mozart effect. For example, Schellenberg, Nakata, Hunter & Tamoto (2007) found that Mozart's music improves participants' spatial IQ scores. This account argues that this temporary facilitation in cognitive performance was not specific to Mozart music, but can be induced by any music or noise that elicit arousal and positive affect. Typically, higher arousal and positive affect sounds have a fast tempo and a major key (Schellenberug, 2012). However, the Mozart effect occurs typically after listening to music, and hence whether the arousal and mood hypothesis can explain the effect of background sound (which is listened to concurrently with the completion of the cognitive tasks) remains a question.

On a similar line, Kiger (1989) recognised that "low information load" music seemed to complex cognitive task performance, and argued that the presence of this music induced the optimum arousal level for the subject group. "Low information load" music was described to have repetitive rhythm, with a narrow tonal range (Kiger, 1989). Although some studies found no differences in cognitive task performances between simple and complex music (e.g. Furnham & Allass, 1999), Kiger drew attention to the relationship between background noise and arousal level. A number of studies have demonstrated the influence of arousal on cognition (e.g. Lyvers et al., 2004; Husain et al., 2002). The presence of variation in people's arousal level (e.g. according to personality, Eysenck & Eysenck, 1967) implies that individual differences could interact with the noises and the tasks to affect performance.

Interaction between background sounds and individual differences

Fox and Embrey (1972) showed music facilitate repetitive tasks, especially when it is played just after the arousal level has peaked. Staal (2004) found that noise causes an increase in arousal level, which could increment cognitive performance. These results suggest that sounds are likely to affect people physiologically, which in turn influences their cognition. Berlyne (1974) revealed an inverted "U" function in which optimal preference of stimuli occurs at a moderate stimulus complexity. Accordingly, one can argue that the effects of background noises differ due to the arousal it raised; an over- or under-aroused level are both likely to cause disturbance effect on cognitive task performance. An arousal of an optimal level, however, could facilitate the performance.

The topic of the level of arousal has long been studied with the individual differences in the degree of extraversion. Eysenck's (1967) theory of cortical arousal states that extraverts are under-stimulated, and are predisposed to pursue high stimulation through arousal inducing behaviour. Introverts, on the other hand, are themselves over-stimulated and tend to avoid situations or behaviours that increase their arousal levels. Supportive evidence comes from Geen's (1984) study, in which participants were allowed to adjust the level of noise to an optimum. Extroverts selected higher intensities than introverts. In another experiment, Campbell and Hawley (1982) showed that when studying in a library, introverts were more likely to seek places away from the bustle, whereas extraverts tended to work in those areas. Therefore, people are dispositionally different in the way they perceive, and in their ability to handle, arousal. A piece of music, or a period of noise, can be "enjoyed" differently by different individuals.

When realised the differential effect of distractors on different individuals, and redirecting the focus of research on to the interaction between the two, clearer patterns of distracting effect of background sounds began to emerge. Eysenck's (1981) theory of optimal cortical functioning predicts that the presence of music and noise could help to raise extraverts to an optimal level of arousal. In other words, extraverts will be able to cope with, or even favour the arousal, and improvement their cognitive performance might be observed. Conversely, additional arousal presented by the music or the noise will lead introverts to exceed their optimal arousal; hence, their cognitive performance is very likely to be impaired. A large number of studies demonstrated the distinct responses of introverts and extraverts to background sounds. For example, Furnham and Strbac (2002) showed that although there was no difference in extraverts and introverts' scores on a reading comprehension test in silence, introverts were significantly detrimentally affected by music and noise. The reasons for the decline in cognitive performance of introverts under noisy conditions are likely to be caused by concentration problems and fatigue during mental processing (Belojevic, Slepcevic & Jokovljevic, 2001).

More recently, attempts have been made in combining the three sides of the argument, seeing how the nature of the task, the nature of background sounds, and the individual differences among people together influence cognitive performances. Cassidy and MacDonald (2007) asked participants to complete five cognitive tasks in four different sound conditions. High arousal music produced the strongest distraction and weakened performance the most. They also found introverts were significantly more affected by high arousing music than extraverts and received poor scores on recall tests. Extraverted participants also reported working in more social and arousing environment. This further confirmed Eysenck's (1981) theory, showing that extraverts are under-aroused and need to seek extra stimulation outside to reach optimal arousal.

Dobbs, Furnham and McClleland (2011) explored this effect further by testing whether noise would be as distracting as music. In their study, 118 female secondary school students completed an abstract reasoning test, a general cognitive ability test, and a verbal reasoning test under classroom noise, UK garage music and in silence. Participants' degree of extraversion was also measured. The study found that for all three tests, performance in silence was superior to performance in noise, but the distractive effect of music was test-dependent. The result also revealed significant interactions between the degree of extraversion and performance on all three tests. Extraverted participants' performances were unaffected by the classroom noise, and hence outperformed introverts on all three tests. However, for music condition, this interaction was not found in the verbal reasoning test. Thus, in general, studies combine the three lines of research found that background sounds have a more detrimental effect on introverts' than extraverts' performances on complex cognitive tasks.

Cultural differences

Although not explicitly indicated above, most of the research in this field have been conducted on Western participants. Many studies have tested and discussed the cultural specific variables, and their potential influence on people's personality and cognition. In general, although studies have identified that there are different personality dimensions only present in Easterners (Cheung & Leung, 1998), extraversion was identified among a wide variety of cultures (McCrae & Costa, 1997).

Meanwhile, plentiful studies have established that the cultural differences between Westerners and Easterners have led to their different attributional and cognitively different approach towards a question. For example, Norenzayan, Smith, Kim and Nisbett, (2002) found Easterners are more inclined to a holistic processing style. In their experiments, Asian Americans were more likely than European-Americans to give responses based on the overall family resemblance of the stimuli. Asian people tend to adapt an ontogenetic orientation. Ji, Zhang and Nisbett (2004) observed that East Asians college students are more likely to group things based on their relational-contextual information, whereas Westerner students are more likely to group objects with shared-categories.

These results suggest that Easterners attend more closely to the environment than the Westerners. It raises the possibility that there might be differences in the cognitive abilities between the two groups of people. For some of the cognitive tasks, especially those involves an abstract reasoning component, participants are asked to find the relationship or the underlying patterns of a set of stimuli. This might give Asian an advantage due to their holistic processing style. However, in a study examining the speed of processing and working memory tasks based on arithmetic abilities and visuospatial abilities on American and Chinese, Hedden et al. (2002) found no differences between their performances. Along these lines, testing the effect of background sounds on Easterners could help to confirm if this distractive effect is also universal.

Nevertheless, the present experiment would like to test the effect of a particular dimension of culture, specifically language, which might cause a difference in cognitive performance. Previous research had found evidence that linguistic differences could have an effect on cognitive task performance. Chincotta and Underwood (1997) found that Chinese to be superior on the digit span task due to the shorter pronunciation duration of digits in the Chinese language compare to the English language. It demonstrates that even the superficial differences in language can have a significant effect on cognitive performance. It, therefore, remains a question if the general strategy or the cognitive demands, of a language, could have an effect on cognitive performances.

The Chinese language is more difficult to comprehend compare to English language, due to its uninflected nature. It conveys meaning through word order, adverbials or shared understanding of the context, whereas in English, much information is carried by the use of auxiliaries and verb inflections (Rasmussen, 2010). Accordingly, presumably, much cognitive load and working memory would be taxed in Chinese to work out the relationships between the words. As a result, compare to other cognitive tests, the irrelevant information in music is very likely to have the worst effect on reading comprehension performances among Chinese people.

The present study

The present experiment was a replication of the Dobbs et al. (2011) study on Chinese people. It investigated the effect of extraversion and auditory distraction on three cognitive performances, namely the abstract reasoning, the reading comprehension, and the arithmetic abilities.

Three hypotheses were tested in the current experiment. Based on Hedden et al.'s (2002) study, in which no cultural difference was found in the arithmetic and visuospatial task, the current experiment predict that the experiment result should replicate those found in the Dobbs et al.'s (2011) study; i.e., 1) there will be an effect of background distraction. In particular, for all three tests, the performance would be the best in silence, followed by background music and worst in the presence of background noise. 2) for all three tests, there will be an interaction between degree of extraversion and the distracting effect of background music and noise. A positive relationship between the level of extravasation and performance was predicted in the music and the noise condition, but not in the silence condition. Due to the particular working memory demanding of Chinese, music would have the strongest disturbance effect on the reading comprehension test. It was hence hypothesised that 3) the largest standardised difference in performances between the music and the silence conditions would be found in the reading comprehension test.

Method

Participants

105 Chinese volunteers (61 females) aged between 18 to 33 years old (*M*= 25.89, *SD*= 3.85) participated the experiment. They all spoke Mandarin as their first language and had no extensive foreign experience (living abroad for a period longer than five years). They received a pen with UCL logo to incentivize their participation. Twelve participants failed to finish the whole experiment and were excluded from the analysis, leaving 93 participants (59 females, age *M*= 25.59, *SD*= 3.87). Participant completed the EPI (Eysenck & Eysenck, 1968) to measure their degree of extraversion.

Material

Sounds. The 'noise' contains keyboard-typing sound, general sounds of people, computer and related electronic device sounds (such as keyboard-typing, mouse clicking, and photocopying), and office environmental noise. The samples were downloaded from the website FindSounds, and were mixed together using the GarageBand App on an Apple Macbook Pro laptop. The length of the finished piece was 8 minutes and 19 seconds. The noise was selected so as to be as representative as possible of the everyday working environment of an office. The music selected was Chinese pop songs, because pop music is frequently heard on radio and TV in China so the music style would be familiar to the participants. All the pieces have a median tempo, were vocal and had considerable instrumental layering. The songs chosen were: 青花瓷 (Blue-and-white porcelain, by Jay Chou), 突然好想你 (Suddenly missing you so badly, by May Day), and 人质 (Hostage, by A Mei). The total length of the music was 12 minutes and 11 seconds. The sounds were presented via a loudspeaker placed at the front of the room with the maximum loudness of 65dB for both the songs and the noise.

Tests. The tests were at an appropriate level of difficulty for the sample: (1) Advanced Raven Progressive Matrices Set II (Raven test) (Raven, 1990; see Appendix E for examples) is a graded test of abstract (perceptual) reasoning. It consists of 36 items arranged in the order that increases difficulty more steadily and becomes considerably more complex than other Raven Progressive Matrices test sets. An item contains a figure with a missing piece, below which are eight alternative pieces (one of which is correct) to complete the figure. (2) The reading comprehension (reading test) (see Appendix F for the English version and the Chinese translation version) was compiled from test items presented on the Cubik online assessment practice site. The test is used by companies to filter their job applicants and is designed to measure the ability to understand written information and to evaluate arguments about this information. It consists three small paragraphs followed by several questions (eight, four, four questions respectively) that ask about the information presented in the paragraph. Participants were asked to decide if the questions were “correct”, “incorrect”, or “cannot tell” from the information given by the paragraph. (3) The arithmetic test (Lock, 2008) (see Appendix G for the English version and the Chinese translation version). The test consists 20 simple arithmetic questions, each with the same format. Participants were asked to make ten simple calculations per question to get a correct answer. The number and the required calculations can be given either in mathematical symbols or written language.

IQ scores. IQ scores of participants were measured. The test chosen was Cattell Culture fair III test (CFTIII test), which consists of 40 graphically presented items (Cattell, 1949). Each item contains a sequence of figures, below which are several alternative pieces. The correct answer is the piece that follows the pattern the best. This test was chosen due to the advantage that it intended to estimate intelligence in a way that is independent of cultural experience or educational level (Cattell, 1949). The test also allows an estimate of IQ without complete the whole tests by counting the number of correct answers. This is an advantage considering the time constraint of the present experiment.

All the tests that have items or instructions originally written in English (i.e. the EPI, the reading test and the arithmetic test) were translated into Chinese by the experimenter. Another Native Chinese speaker, with no knowledge of the original English version of the tests, translated the tests back to English. The translated-back-to-English version and the original version of the tests were compared to check the accuracy of the translation.

Design and Procedure

In a 3x3 mixed design, participants were randomly assigned to one of three groups (group A: *n*= 31; group B: *n*= 30; group C: *n*=32). The random allocation of participants to task and background sound condition combinations was achieved using a Latin square design.

Participants received the tests in a quiet room with 2-9 other participants and were not able to see any other individual’s responses. They completed the three tasks in random orders; one task in the noise condition, one in the music condition and one in silence. For each test, participants were given 4 minutes and were instructed to attempt as many questions as possible while keeping their best accuracies. After the background music condition, participants were asked to indicate whether they had heard the songs before, and to rate their level of affection to the songs on a scale of 1 to 8, where 1 indicated "do not like it at all", and 8 indicated "like it very much". Next, they finished the CFTIII and the EPI. The CFTIII was done in the same fashion as the three tests. For the EPI, they were instructed to finish the whole test and were able to take as much time as they need. Subsequently, they provided demographic information including their age, gender, education, preference for music and frequency of listening to music per day. In total, the whole experiment lasted around 35 minutes.

Results

A boxplot revealed that there were two outliers, one in the CFTIII scores and one in the arithmetic scoresThese two values were removed from the following analysis.

Insert Tables 1 and 2 here

The correlation matrix presented in Table 1 shows that the performance on both the Raven test and the test significantly and positively correlated with the performance on the arithmetic test. Both the performance on Raven test and the reading test, but not the arithmetic test, significantly and positively correlated with the performance on the CFTIII test, the IQ estimate.

Table 1

The correlation matrix of the measures of cognitive ability and extraversion.[a]

	Extraversion	Raven	Arithmetic	Reading
Raven	.034			
Arithmetic	.061	.332**		
Reading	.046	.093	.230*	
CFTIII	.174	.383**	.109	.345**

[a]***: correlation was significant at the 0.01 level*

**: correlation was significant at the 0.05 level*

A one-way ANOVA indicated that there was a significant difference on CFTII scores among the three groups, $F(2,92)=4.40$, $p=.015$, with group A ($M= 4.07$, $SD=1.53$) and B ($M= 4.07$, $SD=1.56$) higher than group C ($M= 3.13$, $SD=1.26$) (see Figure 2). Thus, the present analysis needed to use the CFTIII score as a covariate to control for IQ.

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In addition, the present study decided to use hierarchical multiple regression (rather than ANCOVA) as the method of analysis because of the loss of statistical power and other problems associated with the dichotomization of quantitative variables (see MacCallum, Zhang, Preacher, & Rucker, 2002). For each of the three tests, a model was constructed with CFTIII scores as a covariate, background sound (dummy coded) as one predictor and extraversion as a (continuous) second predictor. An interaction term between background sound and extraversion was also included. Prior to the analysis of performance on each test, the extraversion variable was centred, so that the main effect of background sound could be examined at the mean level of extraversion (i.e. a comparison of the adjusted means). These means are presented in Table 2.

The Advanced Raven Progressive Matrices Test Set II

The model revealed no significant main effect of extraversion, $F(1,85)= 1.04$, $p=.31$, $R^2= 1.0\%$. There was also no significant main effect of background sound, $F(2,85)= 0.86$, $p= .43$, $R^2= 1.7\%$. There was no significant interactions, $F(2,85)=1.189$, $p= .31$, $R^2= 2.3\%$. The standardised difference in performance between the music condition and the silence condition was $d= 0.09$.

The arithmetic test

The model revealed no significant main effect of extraversion, $F(1,84)= 0.02$, $p= .90$, $R^2= 0.0\%$. There was also no significant main effect of background sound, $F(2, 84)= 1.03$, $p= .36$, $R^2= 2.3\%$. There was no significant interaction, $F(2,84)= 0.35$, $p= .71$, $R^2= 0.8\%$. The standardised difference in performance between the music condition and the silence condition was $d= 0.13$.

The reading comprehension test

The model revealed no significant main effect of extraversion, $F(1,85)= 1.04$, $p= .31$, $R^2= 1.0\%$. There was also no significant main effect of background sound, $F(2,85)= 0.21$, $p= .81$, $R^2= 0.4\%$. There was also no significant interactions, $F(2,85)= 0.77$, $p= .47$, $R^2= 1.8\%$. The standardised difference in performance between the music condition and the silence condition was $d= 0.39$.

Discussion

The present study aimed to investigate the effect of background auditory distractions and level of extraversion on three cognitive task, namely the Advanced Raven Progressive Matrices Set II (Raven, 1990), an arithmetic test (Lock, 2008), and a reading comprehension test (compiled from the Cubik online assessment). The result revealed that there was no significant main effect of background sound, nor a significant interaction between level of extraversion and the distracting effect of background music and noise. The effect sizes revealed that, as a comparison to silence, music had the strongest effect on the reading test, but in a positive way. Thus, the present study failed to support the hypotheses 1) there will be an effect of background distraction; and 2) there will be an interaction between degree of extraversion and the distracting effect of background music and noise; but supported the hypothesis 3) music would have the strongest disturbance effect on the reading comprehension test.

Although the present experiment was not able to test all participants in a single venue, for each test venue, participants were allocated to all three groups. In other words, all of the tests were carried out by participants under different background conditions in each venue. Thus, the lack of main effect or interaction was very unlikely to be due to the differences in testing condition. However, it should be noted that participants were tested in groups instead of individually. This social situation might cause sufficient distraction, which leads to the limited distracting power of the music and the noise. In the present experiment, every attempt was made to ensure a quiet, orderly testing environment, so this may not have occurred. Nevertheless, it would be advised to test participants individually to ensure social factors do not intervene the distraction.

The present study was not able to find a main effect of different types of backgrounds distractions. This was partially in line with some of the previous findings (e.g. Furnham & Allass, 1999, Furnham & Stephenson, 2007). However, Furnham and Stephenson (2007) argues that the reason for their non-significant results might due to the music and the noise was very similar, and that they did find a trend in the predicted direction, although not statistically significant. Inspection of the histogram of the current data suggests that there was no ceiling or floor effect on the performances on any of the tests (see Appendices A, B, C for the histogram). Thus, the problem in replicating Dobbs et al.'s (2011) results on Western participants is less likely to be caused by the difficulties of the tests. If indeed, this was the case, participants' performances should not spread normally, but instead, distributed densely on one side, indicating their inability or strong ability at a particular test. It could be that the tests were, in general, easier for the Chinese people, so that they are less affected by the distractions. Research has indicated that may be only for complex tests will the background music or noise has an effect (Evans & Johnson, 2000). However, the present experiment does not have both the Chinese and the Westerners' scores on the tests to draw a conclusion.

A possible explanation for this finding was due to the difference in class size among Chinese and Westerner societies. Typically, the class-size in China is around 50 students (OECD, 2012), with some schools extends to 70 or 80. When in fact, in the CEOD countries the average figure was 23 students, with the United Kingdom, in where the Dobbs et al. (2011) study was conducted, below 20 students (OECD, 2012). Moreover, in China, students do most of their study and practice in the classroom rather than other places such as libraries. This implies that in their training on a range of cognitive performances, from arithmetic to language comprehension, Chinese students are exposed to a higher amount of noise, and social interaction, in comparison to most of the Western countries. Banbury and Berry (1997) have found that people's performance on a memory task can be habituated to office noise just after 20 minutes. Thus, it is very likely that, Chinese people are used to working on complex cognitive problems under noisy environments, and therefore, the presence of music or noise would not have a substantial effect on their performances. However, research should be conducted to check whether Chinese people are truly more habituated to noisy environments, and identify the cognitive tasks that are likely to be influenced by this habituation effect.

Despite these findings, the participants gave some interesting feedbacks after their participation. A number of people reported that they found the music "annoying", and "could not help themselves but sing along with it". 74% of participants confirmed that they have heard the music before, and the average liking score was 5.59 (of a maximum score of 8), indicating that by and large they liked the music. Furnham, Trew and Sneade (1999) found music that is most distracting is fast, familiar vocal music that is often known by, and chosen and liked by the user. According to how the participants felt, it should be expected to see an adverse effect of music on people's performances. The result says otherwise. It is interesting to see this differences in people's meta-cognition and their actual performance. On the other hand, all of the music selected for the present study have a major key (Blue-and-white porcelain: A major; Suddenly miss you so badly: D major; Hostage: C major), which, according to the arousal and mood hypothesis, makes them positive affect music. A large number of studies find that positive affect enhances performances on cognitive tasks (e.g. Isen, 2008). In addition, 41% reported that they would listen to music while studying or working. Therefore, it might be the case that the positive affect reduced the negative distracting effect of the music, and that because a large proportion of people prefer to work with music, its effect was not strong anyways.

The present study was also not able to reproduce the interaction that previous studies found between degree of extraversion and tests performance under background distraction. This was partly in line with some of the previous studies (e.g. Furnham & Stephenson, 2007; Furnham & Strbac, 2002). Furnham and Strbac (2002) found on only one of the three tasks did extraverts outperform introverts under background noise and music, but the other two showed this trend with non-significant statistics. They argue that non-significant results may be partially explained by the median split methods used to assigning participants' degree of extraversion. One possible explanation for the current non-significant result was that the standard deviations of NEO scales are consistently smaller in Asian countries than in the West (McCrae, 2002), and hence the differences in extraversion scores were not big enough to bring about an interaction. However, again based on inspection of the histogram of the data, there is a wide range of extraversion scores, and they are in general normally distributed (see Appendix D for the histogram). Thus, cultural differences in degree of extraversion cannot explain the findings.

Likewise, this result could be explained by the habituation to noisy environments as well. Research on habituation have found that repeated presentation of the same stimulus is likely to cause a decrease in the strength of a response, and this effect could be long-term (Bouton, 2007). In particular, studies have also found that prolonged exposure to noisy environment reduces arousal responses, such as heart rate and core body temperature (e.g. Masini, Day and Campeau, 2008). Thus, it is possible that the prolonged experience in studying in noisy environments caused Chinese people to habituated their reaction (increase in arousal levels) towards distractors; hence, a smaller level of arousal would be caused by the distractor. Accordingly, the background distractors were not stimulating enough to either lift the arousal level of extraverts to reach, nor over-stimulate introverts to exceed, their optimal arousal level. Thus, no significant differences would be found between extraverts and introverts under different testing conditions. However, it is crucial to note that this argument requires further research on Western and Eastern human participants to examine and confirm if there exist differences in changes in physiological measures under noise and music.

The present study found that music has the strongest effect on reading test, followed by the arithmetic test, and then the Raven test. However, for both the reading and the Raven test, the effect was in the opposite direction as predicted; music enhanced performances. Yerkes and Dodson (1908) suggested that the optimal internal arousal levels for particular tasks vary depending on the task difficulty, the simpler the tasks the higher the optimal arousal levels. Over the years, there has been quite a few research indicating the existence of this correlation (e.g. Anderson, 2000; Calabrese, 2008). Thus, one possible explanation for the pattern found in the present experiment was that the arithmetic test used in the present experiment was more cognitively complex than the reading test, which was, in turn, more difficult than the Raven test. This means that the arithmetic test had the lowest optimal arousal level, followed by the reading test, and then the Raven’s test.

During testing, the music elevated participants’ arousal levels, which were so high that exceeded the optimal level of the arithmetic test, and decreased participants’ performance. On the contrary, the lifted arousal levels were closer to the optimal level for the reading test but still far from the optimal level of the Raven’s test. This caused the higher improvement in the reading test, and a small increase in the Raven’s test. As discussed above, because Chinese people may be habituated to work under noisy environments, the music should not cause too much of changes in the arousal level. In other words, the level of arousal elevated by the music was not higher than the optimal level of the arithmetic test enough to cause significant impairment, yet not high enough to reach the optimal level of both the reading test and the Raven test. This argument also concurs with Hallam, Price and Katsarou’s (2002) suggestion that the effect of music on task performance may be mediated by arousal, rather than cognitive directly.

Why could the arithmetic test be more difficult than the reading test and the Raven test? The arithmetic test applied by the present involves more than just arithmetic ability, but possibly language comprehension as well. The questions in this test were given in the way that, for some steps, people have to work out the underlying relationships between the previous and the next steps (see Appendix E for the test in Chinese and English). Moreover, some of the expressions do not have a word-to-word translation, and are rarely used in Chinese (e.g. “double it”). Thus, in some way, one can claim that the arithmetic test is more complex for Chinese participants than the reading test, which only tested language comprehension abilities. On the other hand, the reading test requires one to mentally refer back to the passage while using judgment skills, whereas in the Raven test all the information is presented clearly on one page. Moreover, in the Chinese national curriculum, such “find the pattern” questions were frequently trained and examined in the Maths classes, which might also make them more familiar, and potentially easier, for Chinese participants.

One limitation of the present experiment was that, due to time constrains, participants were not given time to complete the entire tests, but instead, asked to complete as many questions as possible. Thus, the scores from the tests were only indications of the extend to which background distractors could influence the cognitive performances. Moreover, because participants were given more questions than they could answer in the given amount of time, it was very likely that they had adapted different strategies for completing the test in order to score as high as possible. To illustrate, even though it was instructed at the beginning that they should answer the questions in the correct order and not skip any questions, the experimenter found that few participants chose to skip earlier questions that they were struggling with and moved on to the later ones. Although the data from these participants were removed, it remains a possibility that other strategies might be adapted by the participants and could not be checked up by the experimenter (e.g. give a random answer and move on to the next one). Thus, it is recommended for future replications research to give enough time to participants so that they could complete the entire tests.

Future research should be conducted so that direct comparisons could be made between people from different cultures. The present experiment only had experimental data from the Eastern-culture participants, and hence, could only make comparisons with previous findings. A study with participants coming from both Western and Easter countries could allow a direct comparison of the performance result between the two groups. Having people from both groups could control for the test being administrated, background distractions being played, and the testing conditions. This would permit a strong conclusion on the cultural differences in the effect of background distractions on the cognitive performance of introverts and extraverts.

The present experiment has important implications. At the group level, the results suggest that a general (yet, in this case, complicated) pattern found in one culture does not necessarily translate to another. People's past experience, knowledge structure and perception style all play a role in determining whether a particular stimulus would cause a response. The inability to replicate Western culture results highlight the problem in the generalisation in psychological findings. Indeed, many attempts to replicate notable experiments in other cultures found to have varying success (Smith, Bond & Kâğıtçıbaşı, 2006). Thus, the present research encourages more cross-cultural repetition on this topic, as well as others that have found sound conclusion yet lack cross-cultural validation. On an individual level, the results suggest that the effect of background sounds on cognitive performance varies from people to people. Music and noise could improve or deteriorate a person's cognitive abilities, depending on their individual differences. One should not simply accept and adapt the scientific findings without considering their own abilities and limitations. However, it should be noted that the sounds used in the experiment was played in a quiet environment with a rather low volume.

Having high volume noise or music in a not-quiet environment might cause impairment in people's performances.

In conclusion, the present experiment aimed to test the distractive effect of background music and noise on different cognitive task performances, and how does individual differences in the degree of extraversion influences it. The result suggests that on Chinese people, music and noise do not have a much distracting effect, on both introverts and extraverts. The music had its largest influence on the reading comprehension test, but in a positive way. These findings are different from most of the previous literature testing Westerners. The differences might be explained by the differences in the class size among two cultures. The larger class size causes Chinese to be habituated to noisy environments, which leads to a smaller response to the background distractions. However, the present experiment encourages more replication research testing both Chinese and Western participants to allow the validation of the results, and their cross-cultural generalisation.

References

Anderson, J. R. (2000). *Cognitive psychology and its implications*. 5th Ed. New York: Worth.

Baddeley, A., Eysenck, M., & Anderson, M. (2009). *Memory*. Hove [England]: Psychology Press.

Banbury, S., & Berry, D. (1997). Habituation and dishabituation to speech and office noise. *Journal Of Experimental Psychology: Applied, 3*(3), 181-195.

Belojevic, G., Slepcevic, V., & Jakovljevic, B. (2001). Mental performance in noise: the role of introversion. *Journal Of Environmental Psychology, 21*(2), 209-213.

Berlyne, D. E. (1974). *Studies in the New Experimental Aesthetics: Steps Towards an Objective Psychology of Aesthetic Appreciation*, New York: Halstead.

Bouton, M. E. (2007). *Leaning and behaviour: a contemporary synthesis.* Sunderland [England]: MA Sinauer.

Brand, J. L., & Smith, T. J. (2005). Effects of reducing enclosure on perceptions of occupancy quality, job satisfaction, and job performance in open-plan offices. *In Proceedings of the Human Factors and Ergonomics Society 49th Annual Meeting, 49,* 818 – 822

Calabrese, E. (2008). Stress Biology and Hormesis: The Yerkes–Dodson Law in Psychology—A Special Case of the Hormesis Dose Response. *Critical Reviews In Toxicology*, *38*(5), 453-462.

Campbell, J., & Hawley, C. (1982). Study habits and Eysenck's theory of extraversion-introversion. *Journal Of Research In Personality*, *16*(2), 139-146.

Cassidy, G., & MacDonald, R. (2007). The effect of background music and background noise on the task performance of introverts and extraverts. *Psychology Of Music*, *35*(3), 517-537.

Cattell, Raymond (1949). *Culture Free Intelligence Test, Scale 1, Handbook*. Champaign, IL: Institute of Personality and Ability Testing.

Cheung, F. M., Cheung, S. F., Leung, K., Ward, C., & Leong, F. (2003). The English version of the Chinese Personality Assessment Inventory: Derived etics in a mirror position. *Journal of Cross-Cultural Psychology*, *34*, 433–452

Cheung, F. M., Leung, K., Fan, R., Song, W. Z., Zhang, J. X., & Zhang, J. P. (1996). Development of the Chinese Personality Assessment Inventory (CPAI). *Journal of Cross-Cultural Psychology*, *27*, 181–199.

Cheung, F., & Leung, K. (1998). Indigenous Personality Measures: Chinese Examples. *Journal*

Of Cross-Cultural Psychology, *29*(1), 233-248.

Chincotta, D., & Underwood, G. (1997). Bilingual memory span advantage for Arabic numerals over digit words. *British Journal Of Psychology*, *88*(2), 295-310.

Crawford, H., & Strapp, C. (1994). Effects of vocal and instrumental music on visuospatial and verbal performance as moderated by studying preference and personality. *Personality And Individual Differences*, *16*(2), 237-245.

Cubiksonline.com,. (2016). *CubiksPractice*., from http://www.cubiksonline.com/cubiks/practicetests/linkpage.htm

Dobbs, S., Furnham, A., & McClelland, A. (2011). The effect of background music and noise on the cognitive test performance of introverts and extraverts. *Applied Cognitive Psychology*, *25*(2), 307-313.

Dornic S. (1975) Some studies on the retention of order information. In P. Rabbitt, S. Dornic (Eds.) *Attention and performance*. London: Academic Press.

Eysenck, H.J. (1967) *The Biological Basis of Personality.* Springfield, IL: Charles C. Thomas.

Eysenck, H., & Eysenck, S. (1967). On the unitary nature of extraversion. *Acta Psychologica*, *26*, 383-390.

Eysenck, S., & Eysenck, H. (1968). The Measurement of Psychoticism: A Study of Factor Stability and Reliability. *British Journal Of Social And Clinical Psychology*, *7*(4), 286-294.

Eysenck, M. W. (1981). Learning, memory and personality. In H. Eysenck (Ed.), *A model for personality* (pp. 169–207). New York, NY: Springer-Verlag.

Fox, J.G. and Embrey, E. (1972) 'Music: An Aid to Productivity', *Applied Ergonomics 3*, 202–5.

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

Furnham, A., & Allass, K. (1999). The influence of musical distraction of varying complexity on the cognitive performance of extroverts and introverts. *European Journal of Personality*, *13*(1), 27-38.

Furnham, A., & 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*(5), 445-455.

Furnham, A., & Strbac, L. (2002). Music is as distracting as noise: the differential distraction of background music and noise on the cognitive test performance of introverts and extraverts. *Ergonomics*, *45*(3), 203-217.

Furnham, A., & Stephenson, R. (2007). Musical distracters, personality type and cognitive performance in school children. *Psychology Of Music*, *35*(3), 403-420.

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

Geen, R.G. (1984) 'Preferred Stimulation Levels in Introverts and Extraverts: Effects on Arousal and Performance', *Journal of Personality and Social Psychology, 46*, 1303–12.

Haake, A.B. (2006). Music-listening practices in workplace settings in the UK. In M. Baroni, A.R. Addessi, R. Caterina and M. Costa (Eds.), *Proceedings of the 9th International Conference on Music Perception and Cognition.*University of Bologna, Bologna, Italy.

Hallam, S., Price, J., and Katsarou, G. (2002). The Effects of Background Music on Primary School Pupils' Task Performance. *Educational Studies*, *28*(2), 111–22.

Harvard Business Review,. (2013). *Research: Cubicles Are the Absolute Worst*. Retrieved 2 February 2016, from https://hbr.org/2013/11/research-cubicles-are-the-absolute-worst/

Hedden, T., Park, D., Nisbett, R., Ji, L., Jing, Q., & Jiao, S. (2002). Cultural variation in verbal versus spatial neuropsychological function across the life span. *Neuropsychology*, *16*(1), 65-73.

Husain, G., Thompson, W.F. and Schellenberg, E.G. (2002) 'Effects of Musical Tempo and Mode on Arousal, Mood, and Spatial abilities', *Music Perception 20*(2): 151–71.

Isen, A. M. (2008). Some ways in which positive affect influences decision making and problem solving. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 548–573). New York, NY: The Guilford Press.

Iwanaga, M., & Ito, T. (2002). Disturbance effect of music on processing of verbal and spatial memories. *Perceptual And Motor Skills*, *94*(3c), 1251-1258.

Ji, L., Zhang, Z., & Nisbett, R. (2004). Is It Culture or Is It Language? Examination of Language Effects in Cross-Cultural Research on Categorization. *Journal Of Personality And Social Psychology*, *87*(1), 57-65.

Kiger, D. (1989). Effects of music information load on a reading comprehension task.

Perceptual And Motor Skills, *69*(2), 531-534.

Kim, J., & de Dear, R. (2013). Workspace satisfaction: The privacy-communication trade-off in open-plan offices. *Journal Of Environmental Psychology*, *36*, 18-26.

Lesiuk, T. (2005). The effect of music listening on work performance. *Psychology Of Music*, *33*(2), 173-191

Lin, E.J. (2003). Are indigenous Chinese personality dimensions culture-specific? An investigation of the Chinese Personality Assessment Inventory in Chinese American and European American samples. *Dissertation Abstracts International: Section B: The Sciences & Engineering*, *63*(7-B), 3505.

Lock, D. (2008). *Daily Mail 30 second challenge*. London: John Blake.

Lyvers, M., Brooks, J. and Matica, D. (2004) 'Effects of Caffeine on Cognitive and Autonomic Measures in Heavy and Light Caffeine Consumers', *Australian Journal of Psychology 56*(1): 33–41.

MacCallum, R. C., Zhang, S., Preacher, K. J., & Rucker, D. D. (2002). On the practice of dichotomization of quantitative variables. *Psychological Methods, 7,* 19–40.

Masini, C., Day, H., & Campeau, S. (2008). Long-term habituation to repeated loud noise is impaired by relatively short interstressor intervals in rats. *Behavioral Neuroscience*, *122*(1), 210 – 223.

McCrae, R., & Costa, P. (1997). Personality trait structure as a human universal. *American Psychologist*, *52*(5), 509-516.

McCrae, R. R. (2002). NEO-PI-R data from 36 cultures: Further intercultural comparisons. In R.R. McCrae, J. Allik (Eds.), *The Five-Factor Model of personality across cultures* (105–125), New York: Kluwer Academic/Plenum Publishers.

McGhee W., Gardner J (1949). Music in a complex industrial job. *Personnel Psychology. 2*: 405–417.

NASA,. (2004). *Staal, M. A. (2004). Stress, cognition, and human performance: A literature review and conceptual framework.* NASA Ames Research Centre, Moffett Field, CA, United States.

Norenzayan, A., Smith, E., Kim, B., & Nisbett, R. (2002). Cultural preferences for formal versus intuitive reasoning. *Cognitive Science, 26*(5), 653-684.

OECD (2012), Education at a Glance 2012: OECD Indicators, OECD Publishing.

Oldham, G., Cummings, A., Mischel, L., Schmidtke, J., & et al.. (1995). Listen while you work? Quasi-experimental relations between personal-stereo headset use and employee work responses. *Journal Of Applied Psychology*, *80*(5), 547-564.

Raven, J. (1990). *Advanced progressive matrices set II*. Oxford: Oxford Psychologists Press.

Rasmussen, S. (2010). *To Define and Inform*. Newcastle upon Tyne: Cambridge Scholars Pub.

Roberts, J. W (1959). Sound approach to efficiency. *Personal Journal*, *38*(5), 6-8.

Salamé, P., & Baddeley, A. (1982). Disruption of short-term memory by unattended speech: Implications for the structure of working memory. *Journal Of Verbal Learning And Verbal Behavior*, *21*(2), 150-164.

Salamé, P., & Baddeley, A. (1989). Effects of background music on phonological short-term memory. *The Quarterly Journal Of Experimental Psychology Section A*, *41*(1), 107-122.

Sailer, U., & Hassenzahl, M. (2000). Assessing noise annoyance: an improvement-oriented approach. *Ergonomics*, *43*(11), 1920-1938.

Schellenberg, E. G. (2012). Cognitive performance after listening to music: A review of the Mozart effect. In R. MacDonald, G. Kreutz, & L. Mitchell (Eds.), *Music, health, and wellbeing (pp. 324–338)*. Oxford, UK: Oxford University Press.

Schellenberg, E., Nakata, T., Hunter, P., & Tamoto, S. (2007). Exposure to music and cognitive performance: tests of children and adults. *Psychology Of Music*, *35*(1), 5-19.

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

Smith, P., Bond, M., & Kâğıtçıbaşı, C. (2006). *Understanding social psychology across cultures*. London: SAGE Publications.

Smith, A., & Stansfeld, S. (1986). Aircraft Noise Exposure, Noise Sensitivity, and Everyday Errors. *Environment And Behaviour*, *18*(2), 214-226.

Thompson, W., Schellenberg, E., & Husain, G. (2001). Arousal, Mood, and The Mozart Effect. *Psychological Science*, *12*(3), 248-251.

Yerkes, R., & Dodson, J. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology*, *18*(5), 459-482.

Table 1

The correlation matrix of the measures of cognitive ability and extraversion.[a]

	Extraversion	Raven	Arithmetic	Reading
Raven	.034			
Arithmetic	.061	.332**		
Reading	.046	.093	.230*	
CFTIII	.174	.383**	.109	.345**

[a]**: *p<0.01* * *p<.0.05*

Table 2

The adjusted mean scores and standard deviations for the Raven, arithmetic and reading comprehension tests under conditions of silence, music and noise.

	CONDITION		
TESTS	Silence	Music	Noise
RAVEN			
M	8.09	8.37	8.45
SD	3.11	3.03	3.16
ARITHMETIC			
M	5.95	5.53	7.33
SD	3.05	3.17	3.17
READING COMPREHENSION			
M	6.50	7.43	6.17
SD	2.52	2.48	2.42