The effect of background music and background noise on the task performance of introverts and extraverts

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GIANNA CASSIDY AND RAYMOND A.R. MACDONALD
GLASGOW CALEDONIAN UNIVERSITY, UK

ABSTRACT The study investigated the effects of music with high arousal potential and negative affect (HA), music with low arousal potential and positive affect (LA), and everyday noise, on the cognitive task performance of introverts and extraverts. Forty participants completed five cognitive tasks: immediate recall, free recall, numerical and delayed recall, and Stroop. Ten participants completed each of these tasks in one of four sound conditions: HA, LA, everyday noise and silence. Participants were also assessed for levels of introversion/extroversion, and reported their music/noise and study preferences.

Performance was lessened across all cognitive tasks in the presence of background sound (music or noise) compared to silence. HA and LA music produced differential distraction effects, with performance of all tasks being poorer in the presence of HA compared to LA and silence, in the presence of noise than silence across all tasks, and in the presence of noise than LA in three of the four tasks. Performance was moderated by internal arousal, with introverts performing better overall on each task except the Stroop, and appearing to be more detrimentally affected by the presence of HA music and noise.

KEYWORDS: *affective valence, arousal potential, cognitive task, extraversion, introversion*

Introduction

Music is more pervasive now than at any other point in history, functioning not only as a pleasurable art form, but also serving many important psychological functions (MacDonald, Hargreaves and Miell, 2002). In addition, music can play a powerful social role, facilitating communication (O'Donnell et al., 1999), influencing cognitive functioning (Rauscher et al., 1993), arousing deep emotions (Juslin and Sloboda, 2001), and influencing

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the establishment and maintenance of social groups (Hargreaves and North, 1997).

With this in mind, a growing body of literature has addressed how music affects our responses e.g. physiological (Bartlett, 1999), psychological (Radocy and Boyle, 1998) behavioural (Hallam and Price, 1998), emotional (Juslin and Sloboda, 2001) and cognitive (Furnham et al., 1999). However, specific effects are difficult to predict when we consider the many forms of music, and the multiple ways we encounter, process and experience them (Furnham and Bradley, 1997). To fully understand the effects of music we must account for the interaction between the listener, the music and the context within which the task is taking place (Miell, MacDonald and Hargreaves, 2005).

Konecni (1982) argued that all music processing utilizes cognitive capacity, so listening to music may impair cognitive task performance. A number of researchers (e.g. Rauscher et al., 1993) have investigated music's effect on task performance, playing music as a preparation period before tasks are undertaken, suggesting music creates a neuropsychological priming effect. Rauscher et al. (1993) found that spatial IQ scores and the reading comprehension of school children were improved in the presence of Mozart. Conversely, McKelvie and Low (2002) utilized a similar design, but reported no improvement between pre- and post-test scores. However, the majority of relevant research in this area has concentrated on the effects of background music presented during task performance, in comparison with other forms of background sound, i.e. music or noise (Iwanaga and Ito, 2002).

Literature supports the assertion that different forms of music (e.g. stimulating versus sedative) may have differential effects upon participants (Radocy and Boyle, 1998). To investigate why particular types of background music may have specific effects, it is important to take into consideration a number of factors relating to processing requirements, e.g. form (Kiger, 1989), complexity (Furnham and Allass, 1999), genre (MacDonald et al., 2003), familiarity (Hilliard and Tolin, 1979), and tempo (Mayfield and Moss, 1989). Kiger attempted to categorize music in terms of stimulation offered, arguing that slow, soft, repetitive, low-information music provides optimally arousing conditions. Kiger measured information load by categorizing rhythmic complexity, tonal range and repetition, finding 'low information load' music facilitated improved results on a reading comprehension task compared to silence (Kiger, 1989). In contrast, 'high information load' music detrimentally affected performance on the same task. However, Furnham and Allass (1999) found no difference in participants' performance on a comprehension task, recall task and spatial task in the presence of complex and simple music rated on tempo, repetition and instrumental layering.

A number of studies have highlighted the importance of taking genre into consideration. Williams (1961) and Fogelson (1973) found that popular instrumental music reduced performance on a reading comprehension test. A more recent study by Furnham and Bradley (1997) examined performance on immediate and delayed recall memory tasks and reading comprehension in the presence of background vocal 'pop music', reporting negative effects of music on the immediate and delayed recall task only. Blood and Ferriss (1993) found that modality and tempo of music interacted in influencing ratings of anxiety, satisfaction and productivity. Smith (1969) hypothesized that music reduces tension and boredom that may be associated with routine work, acting as a distracter for complex mental work. Others have reported that playing music while performing a repetitive task, particularly just after arousal level has peaked, can raise performance levels (Fox and Embrey, 1972).

Hallam and Price (1998) found a significant improvement in behaviour and mathematics performance for children in the presence of calming music. Effects were particularly strong for children who displayed problems related to constant stimulus seeking and over-activity. Hallam et al. (2002) reported the effects of calming music and aggressive music on the task performance of primary school children. The results indicated that calming music led to better performance on both an arithmetic and memory task, whereas aggressive music disrupted performance. The authors suggest that the effects of music on task performance may be mediated by arousal and mood, rather than cognition directly.

Researchers have also attempted to address the effects of 'noise' on complex cognitive task performance (Hygge et al., 2002; Ylias and Heaven, 2003), emphasizing the detrimental effects of noise as a source of distraction and stress on an individual's cognitive task performance (Kjellberg et al., 1996: Sailer and Hassenzahl, 2000). Banbury and Berry (1998) found that undergraduates' task performance on maths and recall tasks was significantly lessened in the presence of noise (taped office noise) compared to silence, with greater disruption to performance when the noise was present during both learning and recall. However, few studies have compared background music and noise on cognitive task performance. Furnham and Strbac (2002) found no significant difference in task performance in the presence of music and noise.

Task-related factors may influence cognitive processing and highlight differential effects of different forms of music. For example, music may have a positive effect for routine tasks by reducing tension and boredom, but may act as a distracter on complex mental tasks. Smith (1969) provides evidence for the first suggestion, but found that music had no significant effect on complex task performance. Iwanaga and Ito (2002) found perceived disturbance to be highest under vocal music regardless of task type, but found a disturbance effect of instrumental music on a verbal memory task and spatial memory task. The emerging consensus suggests that music is more likely to affect task performance on complex mental tasks.

A number of researchers have linked concepts of aggression and negative behaviour to theories of internal arousal and the arousal potential of music

(Anderson et al., 2003). Addressing arousal as the excitation and complexity level of musical stimuli, North and Hargreaves (1999) asserted that listening to music requires cognitive work. In this way, arousing music (cognitively demanding) would reduce the amount of attentional space available compared to music that is not arousing (less cognitively demanding), limiting processing capacity for simultaneous task performance. They investigated the effects of low arousal potential music (80 bpm, 60 dBA) or high arousal potential music (140 bpm, 80 dBA) on a low demand driving game task or high demand driving task (with the addition of a concurrent backward counting task). They found an interaction between task difficulty and music type, with performance being best in the low demand/low arousal condition. In this light, the current article draws on the distinction between music with high arousal and low arousal potential. The concept of affective valance is also addressed, employing music with high arousal potential and negative affect, and music with low arousal potential and positive affect.

Researchers have also highlighted individual differences as a possible influence upon participants' psychological and physiological responses to background sound, but few studies have investigated this empirically (Furnham et al., 1999). To establish sound's potential to change arousal levels, we need to take into account an intrinsic level of arousal for each individual. Eysenck (1967) proposed that individuals could be differentiated by the amount of externally derived stimulation required to reach an optimal level of arousal, introverts experiencing greater arousal as response to a lower intensity of stimulation than extraverts (see Stelmach, 1981, for a review of supportive literature). In this way, introverts may exhibit an active aversion to such conditions, having experienced an inhibition of excitation once arousal exceeds their optimal level, while extraverts may show stimulation seeking behaviour. We could expect background music to have a more negative effect on introverts, causing their level of arousal to rise beyond their optimal functioning. Kiger (1989) suggested 'low information load music' (i.e. highly repetitive, with narrow tonal range) would induce the optimal arousal level for the introverted group. Alternatively, 'high information load' music (i.e. dissonant, rhythmically varied and highly dynamic) would over-arouse introverted individuals, resulting in avoidance of the stimulation (Salame and Baddeley, 1982). Personal study/work preferences have also been highlighted as influential. Etaugh and Ptasnik (1982) found that individuals who rarely studied with background music showed better comprehension when they learned in silence, while those who frequently studied with music performed better in the presence of music.

Belojevic et al. (2001) investigated individual differences in response to noise, measuring concentration, fatigue and annoyance under noise and silence conditions. He found introverts' performance was slower than that of extraverts in the noise condition, and they reported more concentration problems and fatigue. Furnham and Strbac (2002) found no significant differential distraction effects between music and noise on the task performance of school pupils, but a trend towards worse performance in the presence of background noise. They suggested that these findings could be attributed to high similarity between the complexity of the noise and music used in the study. The current study addresses these issues by investigating the effects of contrasting forms of background music and background noise on the cognitive task performance of introverts and extraverts.

PREDICTIONS

The current study drew on previous research identifying a soothing to stimulating continuum for music (Hallam and Price, 1998), positive and negative affect (Carlton and MacDonald, 2003), and differential arousal potential (North and Hargreaves, 1999). Firstly, the study hypothesizes that music with a high arousal potential and negative affect (HA), music with a low arousal potential and positive affect (LA), general noise and silence would differentially affect task performance. Based on previous research, it was predicted that performance would be poorest in the presence of noise, music (HA and LA) and silence respectively. However, the current study also predicted that HA and LA music would differentially affect task performance, with HA music being more detrimental to performance than LA music.

Secondly, it was hypothesized that task performance would be moderated by introvert and extravert tendencies. It was predicted that introverts' task performance would be significantly more detrimentally affected by the introduction of noise and HA music than extraverts' task performance. Experimental work measuring critical arousal electroderminally and manipulating arousal by caffeine dosages has indicated that playing simple tunes can significantly alter the cognitive-task performance of extraverts and introverts (Smith et al., 1984). Furnham and Allass (1999) found that as complexity of music increased, introverts' performance on a memory recall task and observation task decreased, while extraverts' performance increased. They related findings to the introverts' excitation inhibition mechanism when stimulated to over-arousal.

Thirdly, it was hypothesized that introverts and extraverts would report differential preferences for music listening and studying in the presence of music and noise. Campbell and Hawley (1982) found that extraverts were more likely to choose to work in areas with bustle and activity while introverts were more likely to chose a quiet area, away from noise and distraction. This was supported by Furnham and Bradley (1997) who found that introverts were less likely than extraverts to study with the radio on, and found the presence of music during cognitive tasks more distracting. Daoussis and McKelvie (1986) suggested that task performance in the presence of background sound may be influenced by familiarity with listening to background sound.

Method: Pre-study music selection

PARTICIPANTS

Forty participants rated 40 'popular' music pieces, to generate musical stimuli for the main experiment: 20 university students aged 18–23, 10 adolescents aged 14–16 and 10 non-studying/working adults aged 25–50. The participants were procured on a voluntary and non-incentive basis.

MATERIALS

In light of conflicting literature addressing possible effects of lyrics on task performance, the decision was made to include only music with lyrics, as this is the most frequent choice of adolescents and students in everyday listening situations (Anderson et al., 2003; Wanamaker and Reznikoff, 1989). The music to be rated was chosen through a review of airplay demographic data (e.g. Clyde 1 and 2, and BBC Radio 2), and respondents' suggestions.

PROCEDURE

Participants rated each piece on a five-point Likert-style questionnaire of perceived affect: perceived valence (positive/negative) and arousal (high/low), on separate five-point Likert scales. Participants also rated each piece on perception of aggression (negative–high arousal) and relaxation (positive–low arousal). The music used was rated as 'popular', including a mixture of genre and forms. This allows for affiliation effects but controls for familiarity effects. A decibel meter was used to ensure that participants were presented with stimuli matched for sound level of 60 dB.

RESULTS

A multivariate analysis of variance (MANOVA) was carried out on the most relevant subset of songs, to establish whether there was a main effect for background sound on ratings of characteristics. The dependent measures were performance on the six rating categories (arousal, affect, relaxing, aggressive, familiarity, complexity) with sound condition (subset of most relevant songs) and personality (introversion or extraversion) as fixed factors. The pieces were split into those with high, neutral or low scores on each of the rated characteristics. Those rated as either significantly more positive in affect and low in arousal (LA), or significantly more negative in affect and high in arousal (HA) respectively and which were not significantly different on familiarity and complexity, were selected to form the musical stimuli of the relative conditions (see Table 1).

The MANOVA revealed a main effect of sound on ratings of perceived affect ($F(12,378) = 311.688$, $p < .001$), arousal ($F(12,378) = 331.952$, $p < .001$), aggression ($F(12,378) = 295.874$, $p < .001$) and relaxation ($F(12,378) = 301.767$, $p < .001$).

TABLE 1 *A subset of mean ratings of perceived characteristics of music stimuli, by independent raters*

Ratings	Song 1	Song 3	Song 4	Song 7	Song 10	Song 11
LA						
Mean	4.30	3.16	3.23	3.90	0.17	1.25
SD	0.70	0.69	0.18	0.83	0.46	0.44
HA						
Mean	0.00	0.71	3.81	3.23	4.12	3.11
SD	0.00	0.94	0.75	0.18	0.65	0.88
Familiarity						
Mean	0.47	2.23	0.19	0.32	0.17	1.72
SD	0.63	0.81	0.48	0.79	0.38	0.76

Tukey pairwise comparisons revealed no significant difference between song 1 and song 3 on ratings of arousal potential ($p < .001$), affect ($p < .001$), and labelling as relaxing ($p < .001$) and aggressive ($p < .001$), and song 7 on arousal potential ($p < .001$), affect ($p < .001$), and labelling as relaxing ($p < .001$) and aggressive ($p < .001$). Also, there was no significant difference between 3 and 7 on labelling as relaxing ($p < .001$) and aggressive ($p < .001$), and arousal potential ($p < .001$).

There was no significant difference between song 4 and song 10 on rating of arousal potential ($p < .001$), affect ($p < .001$), and labelling as relaxing ($p < .001$) and aggressive ($p < .001$), and song 11 on rating of arousal potential ($p < .001$), affect ($p < .001$), and labelling as relaxing ($p < .001$) and aggressive ($p < .001$). Also, there was no significant difference between song 10 and song 13 on rating of arousal potential ($p < .001$), affect ($p < .001$), and labelling as relaxing ($p < .001$) and aggressive ($p < .001$).

Songs 1, 3 and 7 were rated significantly less arousing and more positive than songs 4, 10 and 11 and labelled as relaxing (LA). Songs 4, 1 and 11 were rated significantly more arousing and negative, and labelled as aggressive (HA). Therefore, the LA condition was labelled as 'relaxing', and comprised song 1('Distractions', Zero 7, from the album *Simple Things* (2002)), 3 ('No Fear of Falling', I am Kloot, from the album *Acoustic* (2002)) and 7 ('Come a Day', Beth Hirsch, from the album *Early Days* (2000)). The HA condition was labelled as 'aggressive' and comprised song 4 ('Enter Sandman', Metallica, from the album *Metallica* (1991)), 10 ('Attitude', Sepultura, from the album *Roots* (1996)), and 11 ('Black and White', Static-X, from the album, *Machine* (2001)).

Method: Study

PARTICIPANTS

A between-participants design was employed. Forty undergraduate university students (10 male and 30 female) completed the Eysenck Personality Questionnaire – Revised Short Form (EPQ-RS; Eysenck and Eysenck, 1975). Twenty-eight participants were termed extravert (mean EPQ-RS extraversion score 11.38, mean age 21; 10 male and 18 female), and 12 introvert (mean EPQ-RS introversion score 5.4, mean age 21; five male and seven female). There were three introverts and seven extraverts in each sound condition, and a female bias. All participants spoke English as their first language, had normal hearing, normal to corrected vision, and no advanced music training. The participants also completed a standard consent form.

MATERIALS

The study utilized the music generated from the pre-study test: extent to which each song was perceived as arousing, positive/negative, relaxing/aggressive, familiar and complex, assigned by independent raters (refer to details of pre-study music selection earlier). The distinction between instrumental and vocal music, and between genres of music themselves was considered beyond the scope of this study. Background noise was defined as everyday general sound, composed of general classroom/library working sounds, traffic, chatter and conversation including laughter, and presented via a CD player. Sound levels were assessed using a decibel meter, to ensure the level of 60 dB was balanced across conditions. The experiment took place in a soundproof room.

TASKS

The participants were given five cognitive tasks:

1. Participants completed the two-part Stroop Neuropsychological Screening Test (SNST) (Golden and Freshwater, 1994: 1–32; Stroop, 1935). Participants were required to read and vocalize a list of colour names printed in a non-concurrent colour of ink. The participants were given a mark for each correct answer completed within time. The task was *negatively* marked.
2. The immediate recall task consisted of a short 63-word news story from version A of item 6A of the Rivermead Behavioural Memory Test (RMBT) (Wilson et al., 1985). Participants were informed that they would be asked to again recall the passage at the end of the experiment (i.e. delayed recall). All participants completed the task within 10 minutes. To obtain the raw scores, each of the parallel versions of the story was divided into 21 'ideas', with scoring based on the number of 'ideas'. To divert their attention between the immediate and delayed recall tasks, the participants were given two further tasks.

3. The free recall task consisted of 20 everyday six-letter words, not matched for exact frequency. All participants finished within 10 minutes, and were given one point for each word they correctly remembered.
4. The participants were then given a distractive task in the form of a numerical task taken from the Saville and Holdsworth NA4 test of numerical critical reasoning (Saville and Holdsworth, 1993). The data was omitted from the analysis due to limitations in the scope and scoring of the test.
5. The delayed recall task involved recalling the required answer from the original immediate recall task. In previous studies (e.g. Furnham and Bradley, 1997) the interval between immediate and delayed recall was relatively short, e.g. six minutes. This study increased this interval in hope of finding greater differences.

QUESTIONNAIRES

Participants were given three questionnaires to complete: the Eysenck EPQ-RS to ascertain their score on the introversion/extraversion dimension, a music preference questionnaire to provide information about general music preferences, and a study habits questionnaire to provide information about their opinions on music and noise while studying (a forced choice four-point Likert scale).

PROCEDURE

The participants completed a standard consent form, received a brief description of experimental requirements and were informed that they could contact the experimenter at any stage to enquire about the progress of the experiment. Participants were in groups of 10, and told that they could withdraw from the experiment at any time. They were then given the Eysenck EPQ-RS, the music preference, and study habits questionnaires to complete. Participants (n = 10) completed the five tasks in one of four background sound conditions: positive low arousal music labelled as relaxing (LA), negative high arousal music labelled as aggressive (NA), background noise and silence. The extract for each condition was run for the full length of the experiment involving three repetitions, in which the order of the songs was counterbalanced to control for possible repetition effects. The task order was selected in attempt to minimize fatigue through contrast of task type. A measure of fatigue was, however, taken post experiment. The mean experiment time was 45 minutes.

RESULTS

The mean scores and standard deviations for each task indicate differential task performance in the presence of background sound compared to silence (see Table 2). The data also indicate differential task performance between each background sound condition (see Figure 1).

TABLE 2 *The mean cognitive task performance in each background sound condition*

Sound condition		Immediate recall	Free recall	Delayed recall	Stroop
HA	Mean	3.75	5.90	3.10	0.57
	SD	1.38	1.45	1.39	0.12
Noise	Mean	4.70	7.20	3.85	0.32
	SD	2.45	2.04	1.49	0.11
LA	Mean	7.95	8.40	6.50	0.21
	SD	2.63	1.51	2.56	0.01
Silence	Mean	8.90	11.60	7.20	0.22
	SD	1.89	2.50	1.90	0.03
Total	Mean	6.33	8.28	5.16	0.33
	SD	3.00	2.83	2.52	0.17

DATA ANALYSIS

A MANOVA was carried out to establish whether there was a main effect for background sound (music and noise) across cognitive task performance, and to establish the role of personality (introversion/extraversion) in the results found. The dependent measures were performance on the four tasks (immediate recall, free recall, delayed recall and Stroop) with sound condition (noise, HA music, LA music and silence) and personality (introversion or extraversion) as fixed factors.

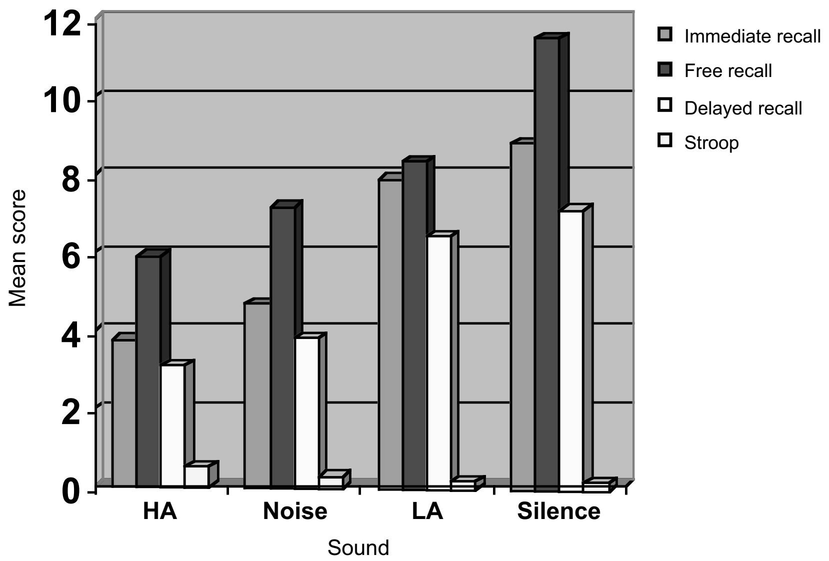

FIGURE 1 *Overall cognitive task performance in each background sound condition.*

Immediate recall

The MANOVA showed a main effect for background sound (silence, HA music, LA music and noise) on task performance ($F(3, 32) = 17.46, p < 0.01$) (see Figure 2). Tukey pairwise comparisons highlighted a significant difference between performance in the silence and HA conditions ($p < .01$) and the silence and noise conditions ($p < .01$), but not between the silence and LA condition ($p = .70$, ns). There was a significant difference between the LA and noise conditions ($p < .01$) and the LA and aggressive conditions ($p < .01$). Task performance was significantly better in silence and LA music than in the presence of noise or HA music. There was no significant difference between performance in the HA and noise conditions ($p = .76$, ns), with both being detrimental to performance. There was a main effect of personality ($F(1, 32) = 6.08, p < .05$), a significant difference in the performance of introverts and extraverts, with introverts performing significantly better than extraverts overall (see Table 2). There was no interaction between personality and sound ($F(3, 32) = 1.506, p = .232$) indicating that background sound condition did not differentially affect the performance of introverts and extraverts (see Table 3).

Free recall

The MANOVA showed a main effect for background sound on task performance ($F(3.32) = 15.69, p < .01$). Tukey pairwise comparisons indicated a significant difference in performance in the presence of silence and HA music

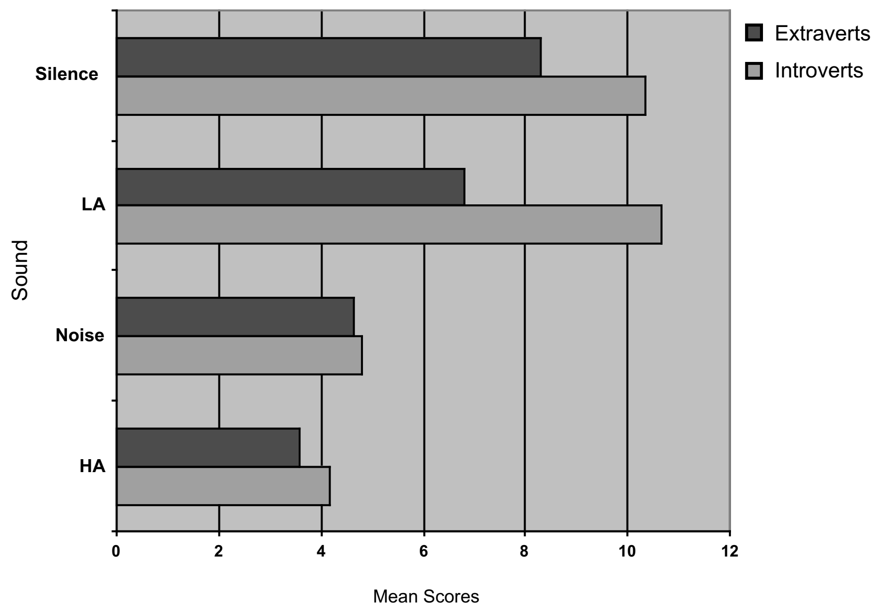

FIGURE 2 *Performance of introverts and extraverts on the immediate recall task.*

TABLE 3 *Mean cognitive task performance scores of introverts and extraverts, in each background sound condition*

	Extraverts					Introverts				
	Overall	HA	Noise	LA	Silence	Overall	HA	Noise	LA	Silence
Immediate										
Mean	5.82	3.57	4.64	6.79	8.29	7.50	4.16	4.80	10.67	10.33
SD	2.50	1.43	2.59	1.40	1.35	3.79	1.44	0.36	3.21	2.52
Free										
Mean	8.12	5.57	7.00	8.40	10.86	9.51	6.67	7.67	8.33	13.34
SD	2.63	1.51	1.21	1.63	2.54	3.247	1.15	2.12	1.52	1.53
Delayed										
Mean	4.78	3.00	3.86	5.29	6.50	6.50	3.34	4.84	9.34	8.84
SD	1.87	1.55	1.63	1.16	0.91	3.44	1.15	0.00	2.93	2.84
Stroop										
Mean	0.30	0.52	0.26	0.21	0.21	0.41	0.70	0.46	0.21	0.25
SD	0.141	9.7	4.63	1.03	1.25	0.206	0.00	0.17	1.16	4.74

($p < .01$), LA music ($p < .01$) and noise ($p < .01$), with task performance greatest in silence. There was a significant difference between the LA and HA conditions ($p < .01$) with performance greater in LA music, but not between LA and noise conditions ($p = .17$, ns), or between the noise and HA conditions ($p = .14$, ns), which were both detrimental to performance. It appears that performance was best in the presence of silence, LA music, noise and HA music respectively. There was no significant effect of personality on overall task performance ($F(1, 32) = 2.47$, $p = .13$).

Delayed recall

The MANOVA showed a main effect for background sound (music and noise) on task performance ($F(3, 32) = 18.49$, $p < .01$) (see Table 2). Tukey pairwise comparisons highlighted a significant difference between performance in the silence condition and HA conditions ($p < .01$), and between the silence and noise conditions ($p < .01$), but no significant difference between silence and LA ($p < .01$), with overall performance being greatest in silence. There was a significant difference between performance in the LA and the HA music conditions ($p < .01$), and the LA and noise conditions ($p < .01$), with performance being greatest in LA music. There was no significant difference between HA and noise ($p < .01$). There was a main effect of personality ($F(3, 32) = 9.07$, $p < 0.01$), indicating a significant difference in the performance of introverts and extraverts, with introverts performing significantly better than extraverts overall (see Table 3).

Stroop

The MANOVA showed a main effect for background sound (music and noise) on task performance ($F(3, 32) = 114.37$, $p < .01$) (see Table 2). Tukey pairwise comparisons indicate a significant difference between performance in the silence condition and the HA condition ($p < .01$) and noise conditions ($p < .01$), with performance best in silence. There was a significant difference between the LA and HA conditions ($p < .01$) and noise conditions ($p < .05$) with performance greater in LA music. There was also a significant difference between performance in the HA and noise conditions ($p < .01$) with HA music having the most detrimental effect on task performance. There was a main effect of personality ($F(1, 32) = 34.36$, $p < .01$), indicating that there was a significant difference in the performance of introverts and extraverts on the negatively marked task, with introverts performing significantly poorer than extraverts overall (see Table 3). There was a significant interaction between sound and personality ($F(3, 32) = 7.72$, $p < .001$), indicating than introverts' performance on the Stroop task was significantly poorer than extraverts in the presence of HA music and noise (see Figure 3).

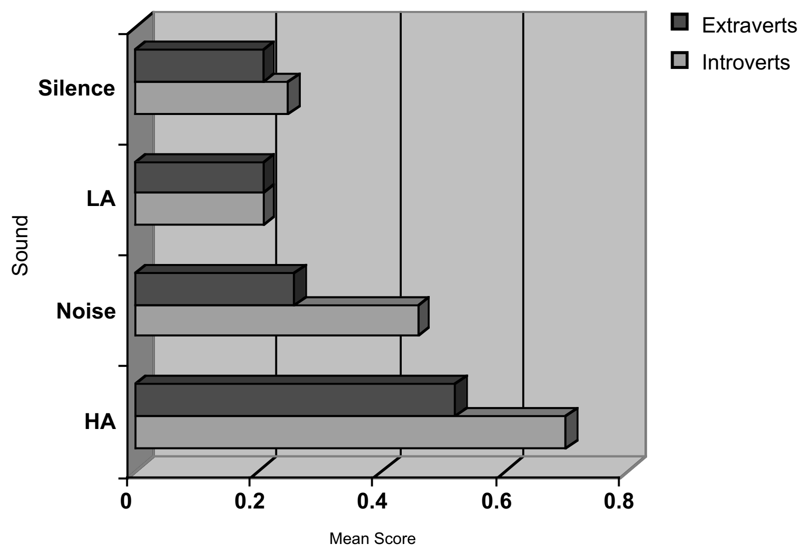

FIGURE 3 *Performance of introverts and extraverts on the Stroop task.*

Questionnaires

- *Study habits:* the MANOVA also investigated whether there was a link between scores on the EPQ-RS questionnaire, and the pre-test study habit/music and noise preference questionnaire. There was a main effect of personality on music preference ($F(1, 32) = 50.61$, $p < .01$), indicating that introverts preferred pop, classical and relaxing characteristics, while extraverts preferred rock, metal and hip hop characteristics. The results also revealed a main effect of personality on noise preferences ($F(1, 32) = 31.76$, $p < .01$). Introverts reported finding background music significantly more distracting than extraverts.

- *Music preference:* Open-ended responses indicated that introverts were more likely to report a deliberate choice of pop, classical and indie music, which is quiet, chilled, while studying and out of a studying context, to seek anxiolytic effects. Extraverts indicated awareness of positive anxiolytic effects of music, but admitted this rarely affected their music choice, preferring more aggressive and rock styles regardless of context.

Discussion

The results indicate that performance on all tasks was poorer while listening to background sound (music and noise) compared to completing the tasks in silence, supporting literature on the negative effects of background noise and music on task performance (Banbury and Berry, 1998). The study also predicted that there would be evidence for differential effects between LA and HA music, in line with literature suggesting differential effects of music which contrasts on a soothing to stimulating continuum for music (Hallam and Price, 1998; Radocy and Boyle, 1998). The results supported this, indicating that listening to HA music was significantly more detrimental to task performance than listening to LA music, across all tasks. Background noise and HA music significantly reduced performance across all tasks, compared to silence, with HA music significantly more detrimental to task performance on the Stroop task only. Listening to noise was significantly more detrimental to performance than listening to LA music across all tasks except free recall. There was no evidence of a facilitation effect of listening to LA music. In fact, listening to LA music displayed a significantly detrimental effect on free recall performance in comparison to completion in silence.

The results support Konecni's (1982) suggestion that music processing takes up cognitive capacity; however, it appears that HA music and LA music may make differing demands upon cognitive processing. North and Hargreaves (1997) suggested that music listening requires cognitive work e.g. analyses of musical components, online temporal processing. They suggested that arousing music (more cognitively demanding) reduces the amount of attentional space available, so when arousing music and task performance simultaneously draw on limited processing capacity, task performance is impaired. The findings indicate that participants who completed the tasks in the presence of HA music and noise were less able to store information for later recall, or suppress irrelevant visual stimuli on the Stroop, than those who completed tasks in LA music or silence respectively.

The nature of the task, our limited attentional resources and differential processing of contrasting forms of music and noise may explain these differing results. The experimental HA music was more unpredictable in structure, timbre and message than the LA music. In contrast, the LA music was more predictable in structure, timbre and message. In this way, the HA music may have been processed or perceived more similarly to noise than to LA music, in line with the findings of Furnham and Strbac (2002). Future study should further address participants' judgment and individual perception of music stimuli's characteristics post experiment.

The hypothesis that task performance would be moderated by introvert and extravert tendencies was supported. Introverts' performance was significantly greater than extraverts on the immediate recall, free recall and delayed recall tasks, and significantly poorer overall on the Stroop task. However, the prediction that introverts' and extraverts' performance would be differentially affected by sound condition was partly supported by the results of the Stroop task. Introverts' performance was significantly poorer in the presence of HA music and noise, suggesting that introverts were more detrimentally effected by the introduction of HA music and noise on the complex Stroop task. These findings may be explained by Eysenck theory of cortical arousal and are supported by similar findings that introverts perform tasks more accurately in conditions of low arousal than extraverts, but more poorly than extraverts in negatively arousing or distracting conditions (see Furnham and Allass, 1999; North and Hargreaves, 1997). It may be that LA and HA music are comparable to Kiger's (1989) assertion of 'low information load' and 'high information load' music respectively, in that HA music over-arouses introverted individuals resulting in distraction and poorer performance (Salame and Baddeley, 1982).

The differential results of the Stroop task may be explained through task type and complexity. The Stroop task involved visual stimulation, suppression and vocalization, unlike the other tasks, which involved visualization and retention. This may suggest a differential role for the visuo-spatial sketchpad. The results from the Stroop task may suggest a heightened awareness or sensitivity to background sound, i.e. a change in potential processing of sound compared to the other tasks and a differential role for the phonological loop. It may be that as demand on cognitive capacity increases, the distractive properties of HA music are enhanced for the listener, with introverts being more severely affected. Armstrong and Sopory (1997) tested participants on phonological recall (digits and numbers) and visuo-spatial working memory in silence, and in the presence of a TV situation comedy recording. The TV condition impaired phonological memory, not spatial performance.

Drawing from previous findings, the study suggests that the presence of lyrics may have enhanced the detrimental effects of instrumental music in comparison to silence (Furnham et al., 1999). Further, we suggest that contrasting lyrical content may play a role in the differential effects of LA and HA music on task performance. A growing body of literature is investigating the specific effects of lyrics in HA popular music, with mixed results (see

Anderson et al., 2003). A shift in attention resources from interpretation of musical meaning towards the conscious or subconscious interpretation of lyrics may increase the complexity/distraction potential of HA music compared to LA music.

Research has distinguished between the effects of instrumental and vocal music, addressing the disruptive effects of background speech on various aspects of cognitive, industrial and educational performance. Studies suggest that the vocal sounds in speech may impair phonological processing, which will affect reading comprehension and learning of verbal information. Irrelevant speech, when compared to non-speech-related stimuli at conversational volume, has been found to be more disruptive to memory when informational load is high (Jones and Morris, 1992). One major related phenomenon is the Irrelevant Speech Effect (ISE), referring to the finding of impaired recall performance in the presence of irrelevant auditory stimuli (Salame and Baddeley, 1982). Banbury and Berry (1998) investigated whether office noise (with or without speech) disrupted memory for prose, and mental arithmetic. Office noise with speech disrupted performance on both tasks, whereas office noise without speech only disrupted mental arithmetic. They also addressed the effects of meaningful speech, indicating that meaningful speech was most disruptive, compared to non-meaningful speech (random words) and silence.

Furnham et al. (1999) investigated the performance of sixth-form pupils (age 17–18 years) on a comprehension task, logic problem and coding task in the presence of silence and background vocal music and instrumental music. The study found vocal music to be more distracting than instrumental. Iwanaga and Ito (2002) examined the disturbance effect of vocal music, instrumental music and natural sound (nature) on memory performance. They observed perceived disturbance to be highest under the vocal conditions, but also evident in the instrumental condition.

However, music plays a meaningful social and emotional role, so may be assigned an 'emotional' as well as a 'musical' meaning (see Juslin and Sloboda, 2001). Tremblay et al. (2000) suggested the acoustic constituents of sound, rather than its source, are most influential in determining the impact of irrelevant acoustic stimuli. In this way, speech itself may not hold a special status in processing, but the accompanying meaning may influence processing. Possible effects may be enhanced by our interpretation of any potential social and emotional messaging, again influenced by individual differences. HA music may have a relatively high negative emotional message content compared to LA music, enhancing the inextricable presence of differential speech content between HA and relaxing popular music. It has been suggested that relatively small demands may be made on the attention capacity if the content of the message is easily understood (Lang, 1995). It may be suggested that university students are highly attuned to emotional arousal and meaningful messaging, and so may be less distracted by music than other potential populations or, conversely, more distracted due to increased personal interest and affiliation with social messaging of popular music. Future research could address this issue across individual differences including, age, preferred music and musical experience.

The prediction that introverts and extraverts would report differential preferences for music listening and studying in the presence of music and noise was supported. Introverts reported finding music and noise significantly more distracting while studying than extraverts, supporting the optimum arousal hypothesis (see Ylias and Heaven, 2003). Introverts reported an awareness and deliberate choice of pop and relaxing music to seek anxiolytic effects while studying, and their preferences also remained consistent out of a studying context. Extraverts reported little awareness and a lack of deliberate seeking of positive affect through music, preferring rock and HA music regardless of context. Extraverts also reported preferring to work in more social and arousing environments. This supports earlier research suggesting that extraverts prefer to study in noisier areas of a library (Campbell and Hawley, 1982). The extravert's higher optimum arousal may mean a need to seek more extreme emotional messaging to achieve the level of arousal met by introverts while in the presence of preferred relaxing music.

The study has yielded robust findings, relevant not only to university students (see Ransdell and Gilroy, 2001) and those who wish to maximize their work potential, study environment and services, but also to those interested in investigating the effects of everyday music listening on our emotional and behavioural state. Further study could utilize a larger sample size, even introversion/extraversion and gender split, to investigate the role of neuroticism, conscientiousness, intelligence and hostility in the results. Research should address the possibility of increased familiarity with repetition of sound material, and the possibility of order effects and fatigue through the constraints of administering immediate and delayed recall tasks.

In conclusion, the current study has highlighted the detrimental effect of sound (noise and music) on task performance, in comparison to silence, and the differential effects of music of contrasting arousal potential and affect. The study has also highlighted the importance of the listeners' individual differences, e.g. personality and preferences, on response. We suggest that a wide range of factors should be taken into consideration when investigating the effects of music on behavioural and affective state. These include musical, environmental, psychological and social factors, which may be inextricably linked. Future research should take these factors into consideration in attempts to move away from viewing music as a unitary stimulus with specific effects on psychological processing, regardless of personality and wider cultural and social issues.

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GIANNA CASSIDY is a PhD student at Glasgow Caledonian University, currently supervised by Dr Raymond MacDonald. She graduated with an MA (Psychology) from the University of Glasgow. Her areas of interest include everyday uses of music, and the role of music listening and preference on computer game performance and evaluation. She is currently investigating the role of music listening and preference on driving game performance, judgment and simulated driving behaviour.
Address: Department of Psychology, Glasgow Caledonian University, Cowcaddens Road, Glasgow, G4 OBA, UK. [email: Gianna.Cassidy@gcal.ac.uk]

RAYMOND MACDONALD is a Reader in Psychology at Glasgow Caledonian University, His PhD, from the University of Glasgow, investigated the educational and therapeutic effects of music workshops for individuals with special needs. He is currently editor designate of *Psychology of Music* and associate editor of *The International Journal of Music Education*. He has published and presented his research extensively and is co-editor of two books (with David J. Hargreaves, and Dorothy Miell), *Musical Identities* (Oxford University Press, 2002) and *Musical Communication* (Oxford University Press, 2005). He has also been Artistic Director for a music production company, Sounds of Progress, working with individuals who have special needs. As a saxophonist and composer he performs internationally and has recorded many CDs.
Address: Department of Psychology, Glasgow Caledonian University, Cowcaddens Road, Glasgow, G4 OBA, UK. [email: Raymond.MacDonald@gcal.ac.uk]