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Does listening to preferred music improve reading comprehension performance?

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Martin, Wogalter and Forlano (1988) showed that reading comprehension was impaired when concurrent lyrical music was played. However, this seems to contradict the music and cognition literature, which proposes that listening to music that one likes increases cognitive performance (Hallam, Price, & Katsarou, 2002; Särkämö et al., 2008; Thompson, Schellenberg, & Husain, 2001; Wallace, 1994). In the current study we asked participants to undertake a reading comprehension task in the presence of the following sound conditions: quiet, liked lyrical music, disliked lyrical music and instrumental music.

So ubiquitous is music in everyday life that both work and non-work activities are often accompanied by it. The famous quote by William Green that 'music is a friend of labour for it lightens the task by refreshing the nerves and spirit of the worker' forms the basis of commonly-held intuitions that have been supported by scientific studies. The most famous example of this is the so-called 'Mozart effect' in which spatial IQ was observed to increase following the listening of a passage of Mozart's Sonata for Two Pianos in D Major (K.488) for ten minutes in comparison with listening to a relaxation tape or sitting in silence (Rauscher, Shaw, & Ky, 1993). Subsequent studies have revealed this phenomenon not to be caused the music of Mozart or other classical composers but by an increase in arousal and mood because of listening to preferred music (Nantais & Schellenberg, 1999; Perham & Withey, 2012; Schellenberg & Hallam, 2005). Music also benefits individuals in other ways such as increasing older adults' working memory performance because of listening to an excerpt of Vivaldi's 'Four Seasons' (Mammarella, Fairfield, & Cornoldi, 2007), autobiographical memory increases in Alzheimer's patients following listening to Vivaldi's 'Spring Movement' (Irish et al., 2006) and cancer patients' mood improved from listening to music (Cassileth, Vickers, & Magill, 2003).

Music, however, can impair performance, for example, as when used as irrelevant sound in the irrelevant sound effect (ISE) paradigm. The ISE is one of the most commonly researched auditory distraction phenomena. Put simply, this robust effect is the poorer performance in a background sound condition compared with a quiet control condition. Typically, the paradigm uses serial recall (the recall, in presentation order, of a list of 7–9 digits or consonants) and participants are told to ignore any sounds that they may hear. The classic finding is that recall is significantly poorer when the sound contains what is termed changing-state information compared with steady-state sound and quiet. As an example, performance is poorer when the sound contains an auditory sequence like 'n, r, p…' compared with when it contains 'c, c, c…'. Two key features need to be present for the ISE to occur. Firstly, as mentioned, the sound must contain changing-state information, and secondly, the task must involve seriation. That is, the task must require participants to use rehearsal as a means to retain and retrieve order and/or item information (see Jones, 1999, for a review).

Explanations of the ISE can be roughly divided into two types (Jones & Tremblay, 2000). Firstly, there are those that propose that the impairment is because of the identity of the items in the task becoming confused with the identity of the items in the irrelevant sound (Baddeley, 1986; Neath, 2000) or that the sound attracts the participant's attention, thus reducing available resources to perform the task (Cowan, 1995; Neath, 2000). However, these are refuted by evidence showing that non-speech sounds also impair performance (Jones & Macken, 1993) and that the sound only impairs performance when the task involves seriation (tasks such as missing item and category recall do not show impairment: Beaman & Jones, 1997; Perham, Banbury, & Jones, 2007).

Interestingly, one of the characteristics of the ISE is that it does not matter what the content of the irrelevant sound is so long as it contains changing-state information. So, performance is equally as poor if the sound is in a language the participant understands or a language with which they have no familiarity (Jones, Miles, & Page, 1990). Further, there is no greater impairment if there is a relationship between the items in the recall task and the content of the irrelevant sound (Jones & Macken, 1995). Thus, recalling a list of consonants is equally as impaired if the irrelevant sound contains consonants or digits. However, there are circumstances in which the semantic content of the irrelevant sound plays a major role in determining impairment, and this is where the task involves semantic processing. Both Martin et al. (1988) and Marsh, Hughes and Jones (2008, 2009) revealed that when the task required processing semantic information (by reading comprehension in the former study and recalling list items according to their respective categories in the latter studies), then performance was poorer when the irrelevant sound also contained semantic information (e.g. lyrical music and English words) compared with when it did not (e.g. non-lyrical music, reversed speech and quiet).

Many studies have explored concurrent music's effects on task performance and there have been a wide variety of populations and tasks used. For example, introverts, compared with extraverts, tend to be impaired on tasks accompanied by background music (Dobbs, Furnham, & McClelland, 2010; Furnham, Trew, & Sneade, 1999) and slow-tempo music elicits better recall of radio advertisements (Oakes &

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North, 2006). Unfortunately these studies either focus on factors that are irrelevant to the current study (e.g. personality type or acoustical properties such as timbre) or do not use reading comprehension as the main task. Although Dobbs et al. (2010) used three tasks—Ravens Progressive Matrices, The Wonderlic Personnel Test and a verbal reasoning test compiled from Bryon (2006)—only the latter two included any items that were similar to the reading comprehension task used in the current study. However, even then, they only comprised a small proportion, hence any relevance between this and the current study is negligible.

So, the findings by Marsh et al. and Martin et al. seem to contradict those in the music and cognition literature reporting that listening to liked music improves cognitive performance. Thus, the current study sought to explore this discrepancy by asking participants to perform reading comprehension tasks under the following sound conditions: quiet, liked lyrical music, disliked lyrical music and non-lyrical music. If the performance is poorest in the liked and disliked music compared with the non-lyrical music and quiet, then it would be consistent with the semantic auditory distraction literature (Marsh et al., 2008. Marsh et al., 2009: Martin et al., 1988: Perham, Banbury, & Jones, 2005). In contrast, the music and cognition literature predicts that the liked music should be better for performance than both the disliked and non-lyrical music (as it would be unfamiliar and less likeable, Ali & Peynircioğlu, 2010). As such, the current study builds upon Perham and Vizard's (2010) study by exploring the impact of music preference on task performance by examining these effects on semantic processing.

METHOD

Participants

Thirty undergraduate students from a South Wales University participated for course credit. Ages ranged from 19 to 65 years, and there was an approximate 50 : 50 ratio of males and females. All participants reported good vision and hearing and were native English speakers. Prior to participation, all participants were asked whether they liked thrash metal music as this genre of music was chosen for the disliked music condition (Materials). Those who did were respectfully declined the opportunity to participate in the study.

DESIGN

A within design was adopted with one independent variable of sound [comprising the four levels of disliked lyrical music (DLYR), liked lyrical music (LLYR), non-lyrical music (NLYR) and quiet (Q)] and the dependent variable of reading comprehension score (ranging from 0–6). The sound conditions for the first 24 participants were fully counterbalanced and for the final six participants, each one was allocated an ordering whereby each sound condition appeared in each position an equal number of times.

MATERIALS

Task

For the reading comprehension task, four passages ('Silent film industry', 'Diversity of life', 'Values and integrity of journalism', and 'Emergence of genetics'), along with their accompanying six questions, were taken from the '10 Real SATs' (The College Board, 2000). SAT tests measure academic progress and allow school teachers to have an understanding of the level reached by their student. They test critical thinking and problem solving and have been used in similar studies (e.g. Perham et al., 2005). Each passage was approximately the same length (70 lines) and the responses were in a multiple choice format with a possible four answers each. Both passages and multiple choice answers were printed onto A4 paper.

Sounds

Participants provided the liked music from their own music collection. The requirements were that it contained lyrics and songs were repeated so that they lasted the length of the task condition (10 min). Chosen songs were from artists such as One Direction, Frank Ocean and Katy Perry.

As with Perham and Vizard (2010) and Perham and Sykora (2012), the DLYR and NLYR were chosen by the researchers and the genre was heavy/thrash metal. Death Angel's 'Seemingly Endless Time' was used for the DM song and Death Angel's 'The Ultra Violence' was used for the NLYR song. Death Angelis a thrash metal band who released their debut album 'The Ultra Violence' in 1987 and they are still releasing critically acclaimed albums and touring.

Given that the DLYR was not chosen by the participants, it was unlikely to be familiar to them (Ali & Peynircioğlu, 2010). This lack of familiarity, coupled with thrash metal music's often inaudible lyrics, meant that the semantic content of the lyrics—which was necessary to explore the semantic effect under investigation—may not have been processed. To ensure that the semantic content of the DLYR music was comprehensible, a pilot study was conducted in which 10 participants listened to Death Angel's 'Seemingly Endless Time' and attempted to identify the lyrics. It was found that participants were able to understand around 75% of the lyrics, and this was deemed a suitable amount for the song to be used in the experiment proper. However, one must consider that in the actual study, participants are explicitly told not to attend to the irrelevant sound so it would be unlikely that semantic comprehension of the lyrical content of the song would be that high.

All music was listened to via headphones, was played at between 65–75 dB(A) and presented via the participant's music player or YouTube on the personal computer.

Ratings questionnaire

A short questionnaire was administered to participants upon completion based on that used in Perham and Sykora (2012). The questionnaire comprised Likert scale questions (ranging from 0–100, with 0 being the lowest and 100 being the highest) that asked participants to rate how likeable, familiar and distracting each sound condition as well as how well they thought they performed in each sound condition.

Procedure

Participants took part individually, or in pairs, in a small laboratory. A standardised instruction sheet informed them that they would read four passages of text and then answer six multiple choice questions on each one. Whilst doing so, they might hear music through the headphones they would be wearing but this was to be ignored as it would not be tested. Although there was no time limit, participants tended to complete each passage of text within 10–15 min during which time the researcher restarted the music (in the music conditions). Following completion of all the passages of text, participants completed the questionnaire and were then thanked for their participation.

RESULTS

Data were collected and analysed for reading comprehension and the questionnaire ratings and are reported in that order.

Reading comprehension performance

As Figure 1 shows, performance was greatest for the quiet and NLM conditions and poorest for the two lyrical music conditions (DLYR and LLYR). A one-way within the analysis of variance (ANOVA) revealed a significant main effect of sound, $F(3, 87) = 8.05$, $MSE = 0.47$, $\eta^2 = 0.22$, $p < 0.05$. Planned contrasts showed that performance in quiet was significantly better than in the DLYR condition ($F(1, 29) = 16.96$, $MSE = 1.71$, $\eta^2 = 0.37$, $p < 0.001$) and the LM condition ($F(1, 29) = 10.43$, $MSE = 1.79$, $\eta^2 = .26$, $p < .05$). No significant differences were observed between quiet and NLYR, and between DLYR and LLYR (all $p > 0.05$).

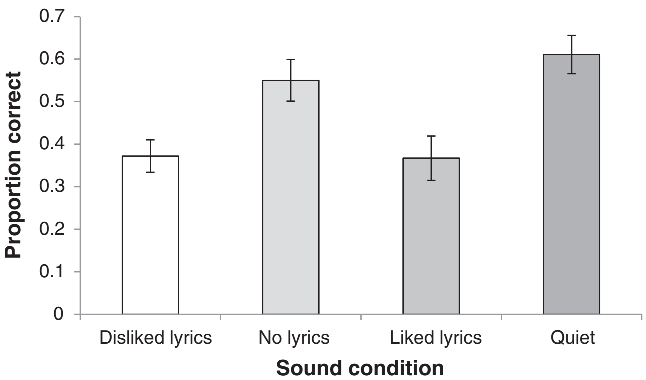

Figure 1. Mean proportion correct recall by sound condition (standard error represented in error bars)

Questionnaire ratings

Table 1 shows that participants perceived themselves to have performed best in the LLYR, the quiet and NLYR conditions as well as feeling that they were the most familiar conditions to them. However, they felt that the LLYR and DLYR conditions were most distracting to their performance, with quiet being much less distracting and NLYR in between LLYR/DLYR and quiet.

One-way within ANOVAs showed significantly effects of sound on all ratings: likeability ($F(2.29, 66.30) = 54.12$, $MSE = 43338.2$, $\eta^2 = 0.65$, $p < 0.001$), familiarity ($F(2.1, 60.95) = 82.82$, $MSE = 70565.53$, $\eta^2 = 0.74$, $p < 0.001$), and distractability ($F(3, 87) = 47.31$, $MSE = 30144.28$, $\eta^2 = 0.62$, $p < 0.001$).

With regard to likeability, planned contrasts revealed that the LLYR condition was thought of as significantly more likeable than the DLYR and NLYR conditions, but there was no difference between the LLYR and quiet conditions and the NLYR and DLYR conditions. Planned contrasts on the familiarity question revealed that LLYR was significantly more familiar than all the other conditions and quiet was significantly more familiar than NLYR and DLYR. Finally, quiet was perceived to be significantly less distracting than the other conditions and NLYR was significantly less distracting than DLYR and LLYR. Both DLYR and LLYR were perceived to be equally as distracting as each other (all $p < 0.001$).

Subjective performance

Table 1 shows that participants thought they performed best in the quiet condition followed by NLYR, LLYR and DLYR. A one-way within ANOVA revealed a significant main effect of sound on participants' subjective estimation of how well they performed on the task ($F(3, 87) = 29.4$, $MSE = 6985.36$, $\eta^2 = 0.5$, $p < 0.001$). Bonferroni post-hocs revealed that participants thought that they performed significantly better in the quiet condition compared to NLYR ($p < 0.05$), DLYR ($p < 0.001$) and LLYR ($p < 0.001$) and significantly better in the NLYR condition compared with the DLYR ($p < 0.05$) and LLYR ($p < 0.001$) conditions. No difference was observed between the DLYR and LLYR conditions.

DISCUSSION

Despite much research reporting that listening to music that one likes confers better health benefits (Cassileth et al., 2003; Rickard, Toukhsati, & Field, 2005; Siedlecki & Good, 2006) and increases spatial awareness when listened to prior to task performance (see Schellenberg, 2005, for a review), the current study reveals that it is equally as disruptive as

Table 1. Ratings of likeability, familiarity and distractability and subjective estimates of performance by sound conditions

	Disliked music	Liked music	Non-lyrical music	Quiet
Likeability	20.17 (27.49)	83.17 (26.38)	29.93 (18.67)	81 (20.49)
Familiarity	12.83 (23.77)	88.33 (23.61)	7.5 (8.48)	70 (31.18)
Distracting	78.7 (23.12)	75.33 (25.32)	46.4 (28.11)	10.43 (22.51)
Subjective estimate	35.77 (21.92)	35.67 (21.76)	52.8 (18.51)	67.33 (19.51)

disliked music when listened to at the same time as performing reading comprehension: both liked (LLYR) and disliked (DLYR) music conditions were equally as disruptive as each other and were both significantly worse than non-lyrical music (NLYR) and quiet (NLYR and quiet produced the same levels of performance). These findings are not consistent with the music and cognition literature and instead concur with the research on semantic auditory distraction.

Many people read whilst having music playing in the background and it is often assumed that this may benefit their understanding of the text. This may be, in part, influenced by prominently reported research showing that listening to music can improve performance (e.g. Rauscher et al., 1993; Schellenberg, 2005). However, in these situations, the music is listened to prior to engaging in the spatial awareness task. The situation of concurrently reading and having music playing in the background is analogous to the ISE and its related research areas (e.g. Marsh et al., 2008; Perham, Hodgetts & Banbury, 2013). A recent explanation of these auditory distraction phenomena posits that the impairment by the background sound is because of a conflict of processing. Marsh et al. (2009) showed that participants engaging in category recall (recalling a list of items according to the semantic categories they belong to) were impaired when the background sound contained semantic information. In the case of reading comprehension and category recall, the conflict in processing arises because of participants semantically processing information in the task and in the background sound. The semantic information in the reading comprehension task and the lyrics in the music both provide plausible candidates for selection to be represented and processed when understanding the information in the task. In order to prevent plausible but inappropriate information—the lyrics in the music—from being selected at the expense of the information in the text, the cognitive system inhibits information from the music. Unfortunately, this comes at a cost, which is the loss of efficient processing of the semantic content of the text.

As predicted, the DLYR music condition was equally as disruptive as the LLYR music condition. This suggests that the semantic content of the DLYR music was understood enough to impair reading comprehension and is comparable with Experiment 2 of Martin et al. (1988) in which the liked music for all participants—likely to have been the researchers' choice—was 'You Light Up My Life' by Joe Brooks. We know from our pilot study that around 75% of the lyrical content was understood when participants attended to this music but it is impossible to know how much was understood by participants in the actual study when they were focusing on the serial recall task. This does raise the question of how much semantic processing is required for impairment to occur. This could be tested by having varying degrees of semantic content in the irrelevant sound but it may be that once semantic processing has been activated, then it persists for a while without any stimuli being present. Indeed, one might also ask whether the music has to be present to exert its effect on semantic processing. Music is ubiquitous in many of our daily activities, and this often results in earworms where songs get 'stuck in our heads' long after we have heard them (Beaman & Williams, 2010; in press). Given our ability to use our imagination and specifically with lyrics (Halpern & Zatorre, 1999; Kraemer, Macrae, Green, & Kelley, 2005), it is possible that imagining lyrical music may have the same effect. Recently, we have shown that when musicians imagine a favourite song they can produce the mood and arousal effect—the increase in spatial rotation performance which was previously, incorrectly, called the 'Mozart effect' (Perham, Lewis, Turner & Hodgetts, 2013).

Although other accounts of the ISE may be used to explain our findings, we feel that they are insufficient. The attentional capture model proposes that performance is impaired by virtue of irrelevant sound capturing attention and thus diverting attention from the task at hand (Cowan, 1995). On this account, liked music, which is likely to be more familiar and consequently less likely to violate participants' expectations of the song because of their long-term representation of the lyrics and melody (Ali & Peynircioğlu, 2010; Hughes, Vachon, & Jones, 2005), should capture attention more than disliked music, which is likely to be more unfamiliar.

Both the working memory and feature models predict that performance is impaired because of the similarity of items/features present in task and the irrelevant sound (Baddeley, 1986; Neath, 2000). However, these models are usually applied to recall tasks where the relationship between the items recalled in the task and those present in the irrelevant sound is clear and precise. With regard to reading comprehension, it is unclear what could comprise this relationship—the semantic content of the passage of test and items in the irrelevant sound, the semantic content of the questions and items in the irrelevant sound or the semantic content of the participants' response and items in the irrelevant sound? This ambiguity renders this explanation defunct at this time. Further, these models have been criticised for being unable to explain how non-speech sounds, which share no items or features with any in the task, impair performance (Jones & Macken, 1995). Further, these explanations do not take into account the interaction between the task and the sound. That is, the processing that is involved in the task is fundamental to whether it is impaired by irrelevant sound. For example, Marsh et al. (2009) demonstrated that impairment from semantic irrelevant sound only occurred when recall of a list of categorisable items were recalled semantically (in categories) rather than in serial order.

With regard to participants' ratings of the sounds, they liked and found more familiar the quiet and liked music conditions compared with the disliked and non-lyrical music conditions, yet found the liked and disliked music conditions (both contained lyrics) more distracting than the non-lyrical music and quiet conditions. Interestingly, their perceptions of their own performance were quite accurate in that they correctly assumed that performance was best in quiet followed by non-lyrical music but they also correctly assumed that performance was equally as poor in the liked and disliked music conditions. This accuracy is in contrast with Perham and Sykora (2012) who observed that participants were inaccurate in perceiving their performance to be roughly equivalent in each of the music conditions when liked music exhibited more impairment than disliked music. This discrepancy is also well-noted in other areas of auditory distraction (Beaman, 2005). One reason for this apparent difference may be that in the current study, the difference between 'poor' and 'good' performance matched whether lyrics were present or not, respectively, which was quite obvious to participants. However, in the Perham and Sykora study, this distinction (between liked and disliked music, respectively) was based on acoustical variation, which may have been less obvious.

The current study augments recent research into music and cognition, and semantic auditory distraction. With regard to the former, it reveals that music does not always aid cognitive performance (Perham & Sykora, 2012; Perham & Vizard, 2010). More specifically, when music is played in the background when people are performing tasks that require seriation (serial recall or mental arithmetic) or semantic processing (reading comprehension), then music can actually impair performance. Music that contains less acoustical variation or no lyrics can reduce this impairment, however. With regard to semantic auditory distraction, the current study adds to the general finding that semantic processing (reading comprehension and category recall) is impaired by lyrical music and speech, respectively, by demonstrating that even if the lyrical music is liked, it is still as detrimental as disliked lyrical music (see Perham & Sykora, 2012, and Perham & Vizard, 2010, for a comparison with seriation-based tasks). This may have implications for those who read or write whilst listening to music, especially students whose understanding of important topics is vital to the successful outcome of their qualification.

In sum, this novel study reveals that despite liking certain lyrical music, it is as detrimental to reading comprehension as listening to disliked lyrical music. Music without lyrics was shown to be less detrimental but, expectedly, performing reading comprehension was best in quiet conditions.

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