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Disliked Music can be Better for Performance than Liked Music

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Summary: Although liked music is known to improve performance through boosting one's mood and arousal, both liked music and disliked music impair serial recall performance. Given that the key acoustical feature of this impairment is the acoustical variation, it is possible that some music may contain less acoustical variation and so produce less impairment. In this situation, unliked, unfamiliar music could be better for performance than liked, familiar music. This study tested this by asking participants to serially recall eight-item lists in either quiet, liked or disliked music conditions. Results showed that performance was significantly poorer in both music conditions compared with quiet. More importantly, performance in the liked music condition was significantly poorer than in the disliked music condition. These findings provide further illustration of the irrelevant sound effect and limitations of the impact of liked music on cognition. Copyright © 2012 John Wiley & Sons, Ltd.

Listening to music that one likes shows remarkable improvements to both health and cognitive functioning, with the latter due to increasing one's mood and arousal (Cassileth, Vickers & Magill, 2003; Hallam, Price, & Katsarou, 2002; Nantais & Schellenberg, 1999; Schellenberg & Hallam, 2005). However, recent research shows that in some situations, musical preference makes no difference — performance is equally as poor on serial recall whether the participant likes the music or not (Perham & Vizard, 2010). A key feature of this latter auditory phenomenon [irrelevant sound effect (ISE)] is the acoustical variation in the sound that is an inherent part of music. However, there may be genres of music whose acoustical variation is much less, such as extreme guitar-based music in which all the individual components of the song are almost indistinguishable from each other. In this case, one may predict that this would show much less disruption to serial recall performance than more conventional music. Thus, it may be possible for an unliked, unfamiliar piece of music to be less damaging to performance than liked, familiar music (although performance would still be best in quiet; see Perham & Vizard, 2010). This contrasts with the music and arousal literature that suggests that liked music improves performance compared with disliked music (Schellenberg, 2005) — although in that paradigm, the music is attended to prior to the task, whereas during the ISE, the concurrent sound is ignored. The current study sought to explore this situation by asking participants to complete serial recall trials in the presence of three sound conditions: quiet, music they liked and music they disliked. As serial recall is widely believed to underpin cognitive activities (Lashley, 1951), the results of this study could reveal that many tasks, such as mental arithmetic (see Jones, 1999), may be potentially impaired by the presence of background music.

Recently, many studies have revealed that listening to music that one likes can improve performance over the short term (e.g. Nantais & Schellenberg, 1999; Schellenberg & Hallam, 2005). These studies emanated from the widely reported study by Rauscher, Shaw, and Ky (1993) in which spatial IQ was increased by around 8 to 9 points following listening to Mozart's Sonata for Two Pianos in D Major (K.488) for 10 minutes. Incorrect reporting of this Mozart effect suggested that it could increase intelligence or general IQ. Arguably, this misreporting has led to many products (e.g. books and compact discs) being produced that were supposed to improve adult's and children's IQ, without any scientific evidence (Tan, Pfordresher, & Harré, 2010).

Subsequent studies have revealed that the Mozart effect may be better attributed to mood and arousal than to the properties of the music produced by a particular classical composer. That is, listening to preferred music increases a participant's mood and arousal levels, which in turn boosts spatial rotation performance. As well as the Mozart effect, there have been Schubert, Blur and even Stephen King effects (see Schellenberg, 2005) where the aforementioned artists' work increased participants' performance. Thus, any stimulus that is capable of increasing someone's mood and arousal — music being just one such example — should boost performance in the short term (Thompson, Schellenberg, & Husain, 2001). Further, this is mediated by how familiar the music is — the more familiar it is, the more liked it is (Ali & Peynircioğlu, 2010). However, ISE research — where the sound is concurrent with activity — suggests that preferred music is detrimental to performance.

The ISE is an auditory distraction phenomenon whereby serial recall — recalling a list of seven to nine items (usually digits or consonants) in their presentation order — is poorer in a background sound condition compared with a quiet control condition (Colle & Welsh, 1976). It is independent of the intensity of the sound [similar disruption whether at the level of a whisper, 48 dB(A), or a shout, 76 dB(A)] and cannot be habituated to, and only around an eighth of people are invulnerable to its effects (see Jones, 1999, for a review). Two key features must be present in order for the ISE to be observed. Firstly, the sound must exhibit acoustical variation. Thus, a changing-state sequence of to-be-ignored (TBI) items such as 'n, r, p. . .' is significantly more disruptive than a steady-state sequence such as 'c, c, c. . .'. This changing-state effect has been demonstrated with many sounds such as speech and non-speech (Jones & Macken, 1993), vocal and non-vocal music (Perham & Vizard, 2010; Salamé & Baddeley, 1989; Schlittmeier, Hellbrück, & Klatte, 2008), office noise with speech (Perham, Banbury, & Jones, 2007a), sine-wave speech (Tremblay, Nicholls, Alford, & Jones, 2000) and tones (Jones & Macken, 1993). For the TBI sound to be

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damaging to performance, the second key feature needs to be present. The task must require the use of seriation, by means of rehearsal, to maintain the order information inherent within the task. For serial recall, this means that participants have to seriate the items so that they can recall them in the order in which they were presented. When the task does not require seriation — such as in the missing item task in which a missing item has to be identified or in category recall where items are recalled to the categories they belong to (Beaman & Jones, 1997; Perham et al., 2007a) — the ISE is not observed. The ISE, then, derives from the conflict of processing two sources of information firstly from the order information within the to-be-recalled items and, secondly, the preattentive processing of order cues within the TBI sound (Jones, 1999).

With regard to music as the TBI sound, as long as it contains acoustical variation — as music generally does — then it should impair serial recall performance regardless of whether the participant actually likes it or not. This was tested and confirmed by Perham and Vizard (2010) showing that liked music (e.g. Lady Gaga and Rihanna) produced similar disruption as disliked music ('Thrashers' by Death Angel). Arguably, music must contain acoustical variation; otherwise, it would not be very interesting to listen to and no-one would buy it. However, some music may contain appreciably less changing-state information so that it is more like steady-state sound. Steady-state sounds in the ISE show little, if any, disruption compared with quiet (Jones & Macken, 1993). In the laboratory, the degree of changing state in a sound can be reduced to a more steady-state nature through a variety of means such as increasing the number of voices within it that is commonly referred to as the 'babble' effect (Jones & Macken, 1995), manipulating the reverberation time of the space in which the sound resides (Beaman & Holt, 2007; Perham, Banbury, & Jones, 2007b) or masking the sound with steady-state sound such as pink noise (Ellermeier & Hellbrück, 1998). During all these instances, the usual undulating nature of the changing-state sound's waveform is 'smoothed', resulting in less changing-state information and consequently less disruption. In music, some genres may contain more of this steady-state quality because of the music being a blur of noise so that the individual elements of the song are relatively indiscernible from each other. One musical genre that may be an example of this is thrash/grindcore metal - a form of extreme guitar-based music. From the ISE research, this suggests that disliked, unfamiliar music could produce better performance than liked, familiar music. Conversely, the mood and arousal literature would predict that music that one likes should elicit better performance than music that one dislikes.

In delineating between these two possible predictions, an ISE paradigm was adopted in which serial recall was performed in the presence of quiet, liked and disliked music, thus extending the work of Perham and Vizard (2010) in exploring the nature of music as irrelevant sound in serial recall performance.

METHOD

Participants

Twenty-five undergraduates from a south Wales university participated for course credit. All were aged between 18 and 30 years, reported normal hearing and vision and were native English speakers. Only participants who disliked thrash/grindcore metal were able to participate. That is, before signing up to participate in the study, they were asked whether they liked thrash/grindcore metal music or not. Those who did were politely told they would be unable to participate in the study.

Design

A repeated-measures design was employed with two variables, namely sound (quiet, liked music and disliked music) and position (one to eight). Each participant received a different order of sound conditions — the orders were counterbalanced such that each sound condition appeared in each position approximately the same number of times.

Materials

Thirty trials were created using *Powerpoint* with each trial comprising eight consonants. These were then equally divided into three sets. Only one-syllable consonants were used with alphabetically adjacent, familiar or phonologically similar combinations, such as GH, LP or GV, avoided to minimise the possibility that participants could use additional mnemonic strategies other than seriation. Each consonant was presented on an individual slide for 1 second with a 1-second blank slide inserted between them. Two practice lists (eight digits) were also created that used the same timings.

Given that the study explored the differences in changing state within liked and disliked music, the authors provided all the songs so that there was more control than allowing participants to provide their own music. Further, it has already been shown that liked music chosen by participants was detrimental to serial recall performance (Perham & Vizard, 2010), so the authors were very confident that their choice of music for the liked music would be liked and also impair serial recall performance. To maximise the preference ratings between the two sound conditions, the authors provided the disliked music as it was considered unlikely that participants would have music they really disliked within their music collection. As with the aforementioned study, all chosen songs in the current study contained vocals as speech tends to exhibit more changing-state information than non-speech (Jones, 1999). For the liked music condition, Infernal's 'From Paris To Berlin' was chosen. This is a fast-tempo dance track in which individual musical elements are clearly identified and is representative of a general popular chart song. For the disliked music condition, three songs from the band Repulsion were chosen — 'Acid Bath', 'Eaten Alive' and 'Splattered Cadavers'. Repulsion is a grindcore metal band whose 1989 release 'Horrified' was cited as a classic of its genre. Their music comprised machine-gun drumming, shouted vocals, extremely distorted down-tuned guitars and deep, muffled basslines that blended into a cacophony of sounds in which the individual elements were barely identifiable from each other. Given that Infernal's song was popular in the UK (reaching number two in the UK charts and becoming the sixth best-selling single of 2006; Relapse records, 2011) and Repulsion played grindcore metal, which is much less common and popular, we could assume with some confidence that the former music was more likeable and familiar. However, a questionnaire was given to participants to confirm this. Both liked music and disliked music were presented within the range 65–75 dB(A). The quiet condition required participants to perform the serial recall task in silence.

Finally, a ratings questionnaire was created comprising 10-point Likert scales for each of the three sound conditions and asked participants about four properties of the sounds — likeability, distractibility, offensiveness and pleasantness.

Procedure

Following the initial screening process (Participants section), the experiment was conducted individually or in small groups of up to five participants in a standard laboratory equipped with *Samsung Syncmaster 171S* PCs. Standardised instructions informed each participant that they were to view 30 lists (in groups of 10) of eight letters and that each list had to be recalled in the order in which it had been presented. Recall could only take place when the word ‘RECALL’ appeared on the screen, and this lasted for 20 seconds. During some of the lists, music would be played through the headphones that participants were told to ignore. After completing the serial recall trials, participants were asked to complete the ratings questionnaire by rating each property on a scale of 1–100, with 1 being the least likeable, distracting, offensive and pleasant and 100 being the most. The ratings questionnaire in Perham and Vizard (2010) required ratings out of 10, whereas we required ratings out of 100. This was because the current questionnaire also asked participants to rate their predicted performance for that sound condition, and we felt that this was more appropriate as a percentage. To prevent any confusion about making ratings on different scales (0–10 and 0–100), we amended all scales so that they were 0–100.

RESULTS

Recall scores

Recall performance was scored according to the standard strict serial recall criterion in which an item was only deemed to be correct if it was recalled in the exact position in the list in which it was presented. Figure 1 shows that the typical serial curve was elicited for all sound conditions and that performance was best in the quiet condition, poorer in the disliked music condition and poorest in the liked music condition.

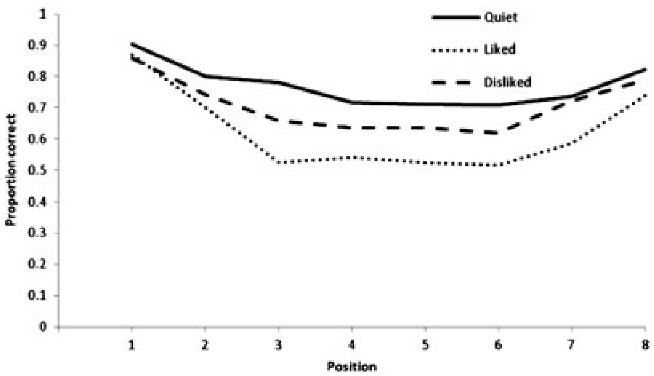

Figure 1. Mean and standard deviation of proportion correct by sound condition

A two-way analysis of variance (ANOVA) revealed a significant main effect of position, $F(7, 168) = 41.43$, $MSE = 1.93$, $p < 0.001$, and a significant main effect of sound, $F(4, 48) = 9.46$, $MSE = 1.18$, $p < 0.001$. The main effect of position was significant because of the production of the typical serial curve, so post-hoc analyses were not conducted. Post-hoc Least Significant Difference (LSD) comparisons on the main effect of sound revealed that performance in the quiet condition was significantly better than the disliked condition and that performance in the disliked condition was significantly better than in the liked condition (all $p < 0.05$). Finally, there was no significant position by sound interaction.

Predicted recall scores

Table 1 shows what percentage performance participants thought they achieved for each of the sound conditions. As expected, they felt that performance was better in the quiet condition, but interestingly, they thought that performance was equally as poor for both music conditions. A one-way ANOVA revealed a main effect of sound, $F(2, 48) = 23.55$, $MSE = 5014.33$, $p < 0.001$, with post-hoc LSD comparisons showing that performance in both music conditions was predicted to be significantly worse than that in the quiet condition ($p < 0.05$); however, there was no significant difference between predicted performance in the two music conditions.

Rating scores

It was apparent that the disliked music condition was deemed to be less likeable and pleasant but more offensive than the quiet and liked music conditions by looking at the means for the ratings. However, both music conditions were thought to be more distracting than the quiet condition.

Each property of the sound conditions was analysed separately using a one-way ANOVA. A significant main effect of sound condition was found for all properties: likeability, $F(2, 48) = 26.54$, $MSE = 16237$, $p < 0.001$, distractibility, $F(2, 48) = 94.65$, $MSE = 43531.54$, $p < 0.001$, offensiveness, $F(2, 48) = 37.56$, $MSE = 22357$, $p < 0.001$, and pleasantness, $F(2, 48) = 12.83$, $MSE = 15879.21$, $p < 0.001$. Post-hoc LSD comparisons revealed that the disliked music condition was rated significantly less likeable and pleasant, and more offensive than the quiet and liked music conditions, but these latter two sound conditions did not differ significantly. Both the liked and disliked music conditions were rated significantly more distracting than the quiet condition, but there was no significant difference between the music conditions (all $p < 0.05$).

Table 1. Mean and standard deviation of percentage predicted recall scores, and the rating scores for likeability, distractibility, offensiveness and pleasantness questions

	Percentage predicted recall score	Likeability	Distractibility	Offensiveness	Pleasantness
Quiet	60.6 (17.34)	53.8 (43.98)	5 (15.28)	0.8 (3.12)	48.6 (44.62)
Liked	35.4 (15.87)	56 (24.79)	75.6 (18.16)	6 (12.99)	53 (26.38)
Disliked	36.8 (20.96)	10.8 (15.12)	75.8 (25.93)	55 (40.05)	9.64 (15.91)

DISCUSSION

The current study sought to explore whether an unliked and unfamiliar piece of music could elicit better serial recall performance than a piece of music that was liked and familiar. Results revealed that although both music conditions produced significantly poorer performance than the quiet control condition, performance in the disliked condition was significantly better than in the liked condition: listening to music whose waveform is steady-state in nature (e.g. grindcore metal) was better for serial recall performance than listening to music that is more changing-state in nature (e.g. pop music). These findings are seemingly incompatible with the mood and arousal literature but are consistent with the changing-state explanation of the irrelevant sound effect (ISE).

Many studies report the beneficial effects of listening to music on cognitive performance where the music is listened to before the task begins and the increase in performance is explained by participant's increase in mood and arousal (e.g. Nantais & Schellenberg, 1999; Schellenberg & Hallam, 2005). Yet, a more common situation occurs when the music is listened to at the same time, and this is the situation that the current study explored. Counter to the expectations of the mood and arousal literature, performance was not better for liked and familiar music in this scenario. Despite Infernal's 'From Paris To Berlin' being deemed more likeable, more pleasant and less offensive than Repulsion's 'Acid Bath', 'Eaten Alive' and 'Splattered Cadavers' and the fact that 'From Paris To Berlin' reached number two in the UK charts in 2006, whereas Repulsion is an obscure band from an unpopular genre (thrash/grindcore metal) that participants were screened not to like, serial recall performance was actually better when Repulsion was the background music. This is difficult to explain from the mood and arousal literature, as music that is liked raises mood and arousal levels that consequently boosts performance (Schellenberg, 2005). Further, this is enhanced when the music is familiar (Ali & Peynircioğlu, 2010). A possible explanation may lie, not with the preference of the music, but with the acoustical properties inherent in the music.

The scenario of performing a task whilst having music playing in the background is analogous to the laboratory scenario of the ISE in which the acoustical variation of the sound is crucial in determining its effect. Here, changing-state sound, in which there is acoustical variation, disrupts serial recall performance compared with a quiet control condition, whereas steady-state sounds generally do not (Jones, 1999). Thus, the sound must demonstrate acoustical changes from one perceptually segmentable entity to adjacent acoustical entities and sharp transitions in acoustic energy demarcate cues to segmentation. Music, arguably, comprises such segmentation cues; otherwise, it would not be entertaining to the listener. However, some music may contain fewer sharp transitions so that the resultant waveform is much smoother and more like steady-state sound: extreme guitar-based music tends to comprise the traditional arrangement of guitars, bass, drums and vocals but all performed at a fast tempo with much distortion. The result could be described as a cacophony of sound in which the segmentation of each individual sound from the next is difficult to identify. A similar effect occurs in the laboratory where the waveforms of changing-state sounds become 'smoothed', thus resembling steady-state sounds and consequently reduced disruption to serial recall performance — steady-state sounds have been used to mask background noise, multiple voices produce the 'babble effect' and the reverberation time of an acoustical environment can be manipulated to alter the acoustical variation of the sound (Beaman & Holt, 2007; Jones & Macken, 1995; Perham et al., 2007a, 2007b). This explanation of steady-state sound supports the observation that in the current study, grindcore/thrash metal music elicited better serial recall performance than pop music, whereas in Perham and Vizard's (2010) study, thrash metal music (Death Angel's 'Thrashers') elicited roughly the same performance. In the latter study, 'Thrashers', albeit from the thrash metal genre of music, comprised sound items that were distinguishable from each other regardless of whether the participants liked it or not, whereas in the former study, the sounds were blurred and therefore resembled steady-state sound more. Further, liked, familiar music could be less damaging to serial recall performance than disliked, unfamiliar music if it comprised much less acoustical variation.

One might argue that the liked, familiar music captured participants' attention more or made it more difficult to concentrate on the task than the disliked, unfamiliar music. This explanation has been frequently used to explain the ISE (see Cowan, 1995) by proposing that each successive changing-state sound item produces an orienting response that diverts attention from the task of recalling items. Given that steady-state sound has little, if any, change between sound items, the orienting response is less or absent. So if the music of Repulsion resembled steady-state sound by virtue of containing less changing-state information, it may have caused much less of an orienting response. Alternatively, one might posit that the more familiar and liked music caused more of an orienting response that produced the drop in performance for that condition. Equally, one could argue that the disliked music would capture more attention because of its unfamiliarity. Thus, the attentional capture account is quite ambiguous with regard to its predictions. This account of the ISE has been criticised elsewhere. Firstly, it assumes that the sound will capture attention regardless of what task the participant is engaged with. Research shows that when the task does not involve seriation — such as the missing item task or recalling items according to the categories that they belong to — then no disruption of the changing-state sound is observed (Beaman & Jones, 1997; Perham et al., 2007a). A second criticism identifies attentional capture as a distinct auditory distraction phenomenon. The 'deviant effect' occurs when an irrelevant auditory item is perceptually deviant from the rest of the irrelevant items, as it violates the algorithm that defines all items in that irrelevant sound and consequently captures attention (Hughes, Vachon, & Jones, 2005, 2007; Jones, Hughes, Marsh, & Macken, 2008). Thus, more disruption is observed when a changing item is inserted into a steady-state irrelevant sound sequence ('c, c, c, m, c, c' compared with 'c, c, c, c, c, c'). Interestingly, more disruption also occurs when a repeated item is inserted into a changing-state irrelevant sound sequence ('f, v, l, y, y, q, x' compared with 'f, v, l, y, r, q, x'; Hughes, Vachon, & Jones, 2007). This contrasts with the attentional capture account which predicts that a repeated sequence would cause less, rather than more, disruption.

The working memory model of the ISE could also attempt to explain the findings of the current study. It proposes that disruption derives from confusion between the phonological content of the to-be-recalled items in the list and the phonological information in the irrelevant sound (Baddeley, 1986). In the current study, it may be suggested that because the phonological information is less perceptible in the Repulsion songs (vocals being shouted and masked by distorted sounds of the other instruments), then there would be less disruption because of this. However, this account has been criticised, as studies have revealed that the ISE is not dependent on the presence of phonological information because disruption is observed, for example, with office noise without speech (Perham et al., 2007a), instrumental music (Schlittmeier et al., 2008) and tones (Jones & Macken, 1993).

Subjectively participants perceived that their performance in the music conditions was significantly worse than in the quiet control condition — a finding that is confirmed, as they felt that both music conditions were equally as distracting as each other. However, the response data show that the liked music condition elicited significantly poorer performance than the disliked music condition. So, although participants realised that background music could be potentially damaging to performance, they were unaware of the mechanisms involved and incorrectly assumed that both music conditions impaired performance equally. These findings concur with previous studies demonstrating that the subjective appraisal of auditory distraction is often inaccurate (Ellermeier & Zimmer, 1997).

In summary, the current study's findings support that of Perham and Vizard (2010) by once again showing that familiar, liked music impairs serial recall performance by virtue, we would argue, of the acoustical variation in the music. That another genre of music, grindcore, revealed significantly less disruption is counterintuitive to the mood and arousal literature but consistent with the changing-state explanation of the irrelevant sound effect. This suggests a limit to the benefits of listening to liked music on cognitive performance: on concurrent seriation-based performance and background music, acoustical variation is more important than musical preference. So, despite the music being disliked, listening to grindcore music whilst trying to remember a sequence of events may be less disrupting than listening to pop music.

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