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Can Preference for Background Music Mediate the Irrelevant Sound Effect?

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Summary: Research suggests that listening to background music prior to task performance increases cognitive processes, such as attention and memory, through the mechanism of increasing arousal and positive mood. However, music preference has not been explored with regard to a more common and realistic scenario of concurrent music and cognition, namely the 'irrelevant sound effect' (ISE). To examine this, serial recall was tested under quiet, liked and disliked music sound conditions as well as steady-state (repetition of '3') and changing-state speech (random digits 1–9). Results revealed performance to be poorer for both music conditions and the changing-state speech compared to quiet and steady-state speech conditions. The lack of difference between both music conditions suggests that preference does not affect serial recall performance. These findings are discussed within the music and cognition and auditory distraction literatures. Copyright © 2010 JohnWiley & Sons, Ltd.

Listening to music is a well-loved pastime for many people but recent research suggests that it provides both health and psychological benefits as well. Not only has it been shown to assist language acquisition in learning impaired children, enhance students' academic performance in exams and alleviate anxiety and depression (Cassileth, Vickers, & Magill, 2003; Rickard, Toukhsati, & Field, 2005; Siedlecki & Good, 2006) but its mere presence improves cognitive functioning. Several studies reveal increases in levels of attention, memory, mental arithmetic and learning (Hallam, Price, & Katsarou, 2002; Särkämö et al., 2008; Thompson, Schellenberg, & Husain, 2001; Wallace, 1994). A popular explanation for this improvement in cognitive performance proposes that if the music is liked then this increases arousal which in turn increases performance (Schellenberg, 2005). However, the general methodology that this explanation refers to requires that participants listen to music prior to performing the task which may be contrary to most people's experience. That is, most people listen to music at the same time as, rather than prior to, performing the task. This concurrent, and arguably more common and realistic, scenario of music and cognition may actually adversely affect performance. Although this paradigm has been extensively researched through the irrelevant sound effect (ISE), preference for the background sound has not been explored. A fundamental characteristic of the ISE is the necessity to maintain order information in the focal task which is argued to be a common component of not only short-term memory (STM) but other tasks such as mental arithmetic, and is a key feature of language learning (Banbury & Berry, 1998; Beaman & Jones, 1998; Saffran, 2002). Further, for the ISE to be observed the sound must contain appreciable acoustical change between successive sound items. Given that music can generally be characterised by this feature (indeed one may argue that music that lacks this feature may not be interesting for the listener), it may be predicted that background music, instead of increasing performance as suggested above, would actually reduce performance. We address this by conducting a study in which serial recall was performed in the presence of five sound conditions: quiet, liked music, disliked music, changing-state speech and steady-state speech. Given the aforementioned benefits that music can have then Knowing the circumstances under which music can and cannot aid cognitive performance may be vital in terms of development and recovery from accidents and illnesses.

Early research into the impact of music on performance suggested that it was actually beneficial to production or simple repetitive tasks (Uhbrock, 1961). Later research in the early 1990s claimed that listening to music (Mozart) prior to task performance increased spatial abilities when compared to either sitting in silence or listening to relaxation instructions (Rauscher, Shaw, & Ky, 1993). Dubbed the 'Mozart effect', it was widely reported by the media and subsequently led to a number of policy changes (see Schellenberg, 2005). However, attempts to replicate the effect failed and a meta-analysis led to the speculation that the Mozart effect was actually attributable to an increase in arousal (Chablis et al., 1999). Since this time, a series of studies reveal that listening to Mozart was in itself not alone in increasing performance. A 'Schubert effect' was also observed for those participants who preferred listening to his music and similarly those participants who preferred a narrated Stephen King story demonstrated a 'Stephen King effect' (Nantais & Schellenberg, 1999). Furthermore, when comparing the music of Mozart with more contemporary music using children, a 'Blur effect' was observed again suggesting an effect of preference (Schellenberg & Hallam, 2005).

The arousal and mood hypothesis proposes that listening to a liked piece of music is just one example of a stimulus that can increase a participant's arousal and mood (see Schellenberg, 2005, for a review). Thus, as long as the participant performs a task, such as listening to music, that they enjoy prior to engaging in the focal task, then arousal is increased and performance improved. Although some studies have explored the potential beneficial effects of listening to music whilst performing the task, which is more similar to the ISE paradigm, however the tasks used, for example mental arithmetic and letter-number sequencing, did not require the use of order information which is a key

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feature of the ISE (Hallam et al., 2002; Schellenberg, Nakata, Hunter, & Tamato, 2007). As such, these studies do not adequately address music preference in a more common and realistic setting of music and cognition such as the ISE. More commonly, studies reveal that listening to music whilst performing cognitive tasks, such as reading comprehension and varieties of memory tasks, show an appreciable drop in performance and not the gains observed in the music and arousal literature (Cassidy & MacDonald, 2007, 2009; Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Strbac, 2002). However, it must be noted that these studies have not explored preference for the music itself.

The ISE is a laboratory example of a very common activity: that of performing a task in the presence of background sound. As such it may be argued that it constitutes a more realistic paradigm in which to explore the effects of music preference on cognition. The ISE is a pervasive phenomenon that has been consistently shown to impair task performance despite explicit instructions to ignore the background sound. It has typically been researched using the serial recall task in which participants are presented with a list of items (around seven to nine digits or consonants) and asked to recall them, immediately or after a short retention period, in the order in which they were presented. During some phases of the experiment, participants are played background sound which they are explicitly told to ignore. A number of key findings reveal that disruption is equivalent irrespective of the intensity of the sound (from the level of a whisper, 48dB(A), up to the level of a shout, 76dB(A), background sound is difficult to habituate to and only about one eighth of individuals are not susceptible to the effects (see Jones, 1999, for a review).

Crucially, there are two prerequisites for the ISE to occur. First, the sound must contain a high degree of acoustical variation over time, so a series of acoustically-changing items such ‘n, r, p…’ is more disruptive to recall performance than a series of acoustically-repeating items such as ‘c,c,c…’ (Jones & Macken, 1993). This has been demonstrated using a variety of sounds such as speech and non-speech (Jones & Macken, 1993), vocal and non-vocal music (Salamé & Baddeley, 1989; Schlittmeier, Hellbrück, & Klatte, 2008), sine-wave speech (Tremblay, Nicholls, Alford, & Jones, 2000), office noise with speech (Perham, Banbury & Jones, 2007a) and tones (Jones & Macken, 1993). Laboratory manipulations in which the changing-state nature of the sound is reduced so that it more closely resembles steady-state sound, such as degrading the sound by low-pass filtering (Jones, Alford, Macken, Banbury, & Tremblay, 2000), transforming speech sounds into sine-wave speech (Tremblay et al., 2000), increasing the number of competing voices within it, commonly referred to as the ‘babble’ effect (Jones & Macken, 1995), manipulating the reverberation times associated with the environmental space (Beaman & Holt, 2007; Perham, Banbury & Jones, 2007b) or masking the sound with steady-state sound (Ellermeier & Hellbrück, 1998; Perham & Banbury, submitted), reveal no disruption. In these latter examples the peaks and troughs within the changing-state sound’s waveform are reduced, thus producing a ‘smoother’ waveform which ultimately decreases the changes in state and therefore results in less disruption. Although some studies have used music as the irrelevant sound in ISE studies, the music was not explored in terms of participants’ preference for it (Kantner, 2009; Salamé & Baddeley, 1989; Schlittmeier et al., 2008) or, using a different arrangement, text recall was aided by presenting the to-be-recalled (TBR) items melodically (Wallace, 1994).

The second prerequisite is that tasks that are susceptible to the ISE, such as mental arithmetic, serial and free recall (Banbury & Berry, 1998; Beaman & Jones, 1998), are those that are highly dependent upon the retrieval of order information—seriation—through the use of rehearsal. Thus, the use of language via the process of rehearsal may be viewed as a vehicle that has been opportunistically hijacked by the STM system for the purposes of reproducing a sequence of presented items. The ease with which a sequence can be assembled and rehearsed—for example sequences that contain well-known item transitions from either the knowledge of their syntax and/or more frequently articulated items—determines its success in being recalled and utilised (*e.g.* Perham, Marsh, & Jones, 2009; Woodward, Macken, & Jones, 2008). Tasks that are not reliant on seriation, such as the missing item task and category recall (Beaman & Jones, 1997; Perham et al., 2007), suffer little, if any, impairment by the irrelevant sound. It is the characteristic of seriation in the serial recall task that makes the ISE important as it is argued to underpin many everyday activities such as free recall (Beaman & Jones, 1998) and mental arithmetic (Banbury & Berry, 1998), as well as being inextricably linked to language learning, production and output (*e.g.* Gupta & MacWhinney, 1997; Jones, Hughes & Macken, 2006; Martin & Saffran, 1997; Perham et al., 2009; Schweppe & Rummer, 2007; Saffran, 2002). Impairment in the ISE, then, derives from a conflict of processing two concurrent sources of order information—one from the intentional use of seriation to maintain the order of TBR information and the second from the preattentive processing of acoustically-variable sound items in the irrelevant sound.

The current study was conducted to explore whether the preference for background music influences performance in a more realistic music and cognition setting—in which music presentation and task performance are concurrent—with a task whose central component, seriation, is important in many everyday activities. If the mood and arousal hypothesis extends to this more common and realistic music and cognition paradigm then preference for the background music should show greater serial recall performance in the presence of liked music than in the disliked music. If preference exerts no effect, then performance in both conditions should be equivalent to each other (and to the changing-state speech condition) given that they all comprise changing-state information. Further, this would suggest limitations in terms of how beneficial the effects of music are on cognition.

METHOD

Participants

Participants were 25 undergraduates from a South Wales University aged between 18 and 30 who participated through

their own volition. All reported normal hearing and vision and were native English speakers. Given that the study relied upon musical preference, only those who disliked thrash metal (a somewhat popular genre of contemporary music) were able to participate. A screening procedure asked potential participants whether they liked this genre of music. Those that replied in the affirmative were informed that they would be unable to take part. The rationale for this procedure is discussed in the Materials section.

Design

A repeated-measures design was employed with two variables, namely sound (quiet, liked music, disliked music, changing-state speech and steady-state speech) and position (one to eight). Each participant received a different order of sound conditions. Given that there were 120 possible orders with 5 sound conditions, the orders were counterbalanced such that each sound condition appeared in each position the same number of times.

Materials

Twenty five trials were created using *Powerpoint* with each trial comprising eight consonants. These were then equally divided into five sets. Only one-syllable consonants were used with alphabetically adjacent, familiar or phonologically similar combinations, such as RS, MP or CP, avoided to reduce 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.

To manipulate participants' preference for a piece of music, two methodological procedures were considered. Firstly, a wide range of music conditions could be used and post-experiment ratings for each one would indicate participants' preference ratings. This procedure had the advantage that each participant would be exposed to the same sound conditions, thus reducing a potential source of variance. However, more sound conditions would be required which would extend the length of the study and it would be difficult to ensure that participants' preference ratings were in the predicted direction given they did not choose them. The second procedure required participants bringing their own choice of liked music which had the benefit of knowing that the preferred pieces of music were ones that the participants definitely liked and that fewer sound conditions were needed. With regard to the disliked music, there were a number of issues that needed to be considered. Firstly, many people's music collections, as one might expect, contain music they actually like hence the reason it is in their collection. Therefore, it may be more problematic for participants to bring in music that they actually dislike. Secondly, an advantage of using one song for the disliked condition would mean that there would be no variation at all. Unfortunately, there would be more variation in the liked music condition as each participant would probably bring in a different piece of music but the benefits of this have been discussed above. Thirdly, although one cannot guarantee that participants would definitely dislike the music, it would be relatively easy for the authors to obtain a song from a genre of music that generally does not appear in the weekly download charts as being representative of music that many people do not buy and consequently may not like. A screening procedure prior to the study would be used to ensure that participants' preferences were in the predicted direction. As it was, the second procedure was employed as it was deemed more practical and its main criticism—more variation in the liked music condition—should not affect serial recall performance as long as the music contains changing-state speech information, which most contemporary music does.

For the liked music condition, participants supplied a vocalised song that they liked on compact disc which was long enough to exceed the serial recall trials (around 5 minutes long). Vocalised songs were required as sounds that contain speech can elicit a larger ISE than non-speech sounds due to their greater amount of changing-state information (see Jones, 1999). Thus, having all music conditions containing vocals would reduce this potential source of variation. Although each liked song had to be around 5 minutes in length, we did not feel that this would be problematic for participants as many songs, especially album tracks, are this length or longer. However, no participant expressed difficulty in fulfilling the criteria for choosing their liked music.

The chosen songs were all from contemporary artists such as Lady Gaga, Rihanna and Arcade Fire and the disliked music was a vocalised song called 'Thrashers' by Death Angel from the album 'The Ultra-Violence' (which exceeded the length of serial recall trials). It was chosen on the basis that, given that it was from a genre of music that many people dislike (thrash metal), most participants would also dislike it. It had a fast tempo, high-pitched screaming vocals and raucous guitar sounds. A screening question was asked prior to the study to prevent anyone participating who did indeed like this music genre. The changing-state speech and steady-state speech conditions were recorded in a male voice in a sound-attenuated booth using *SoundForge*. Each comprised digits presented at the rate of one every 700 milliseconds with 300 milliseconds of silence between them. The changing-state speech condition was a sequence of random digits (1–9 without any familiar date numbers, *e.g.* 1971) which was looped to create 10 minutes of sound. The steady-state speech sound was one digit (three) repeated for 10 minutes. All sounds were presented within the range 65–75 dB(A).

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

Procedure

Prior to participating, participants were asked whether they liked listening to thrash metal. Those that said 'Yes' were not allowed to participate any further. Those accepted participants were instructed to bring with them a compact disc containing a vocalised song that they liked that was between 5 and 10 minutes in length so that it would exceed the length of the trials for that condition. They were run individually or in

small groups of up to five and, after being seated in front of a *Samsung Syncmaster 171S* PC, standardised instructions informed participants they were to view twenty-five lists (divided into five groups) of eight letters for which each one had to be recalled in the order in which it had been presented when they the word 'RECALL' appeared on the screen. Twenty seconds of time was allocated for recalling each list. During some trials, sound would be heard through the headphones but they were told to ignore it. For four of the sound conditions of quiet, changing-state speech, steady-state speech and disliked music, participants remained seated in front of one PC and the sounds were presented via *Powerpoint*. However, when it was time to perform the serial recall task in the liked music condition, they were moved to another PC where the music was played via a compact disc player.

Finally, participants were asked to complete the ratings questionnaire by rating each property on a scale of 1–10, with 1 being the least likeable, distracting, offensive and pleasant and 10 being the most.

RESULTS

Recall scores

Performance was scored according to a strict serial recall criterion. That is, an item was only deemed to be correct if it was recalled in the exact position in the list in which it was presented. As can be seen in Figure 1, the typical serial recall curve was observed for all sound conditions, and it appeared that performance was best in the quiet and steady-state speech conditions, with the liked and disliked music and changing-state speech conditions showing equivalent impairment. A two-way ANOVA revealed a significant main effect of position, $F(7, 168) = 20.43$, $MSE = 2.72$, $p < 0.001$, and a significant main effect of sound, $F(4, 96) = 6.17$, $MSE = 0.89$, $p < 0.001$. The main effect of position was not explored any further as any differences would be due to the elicitation of the typical serial curve. *Post hoc* LSD comparisons confirmed that the quiet and steady-state speech conditions produced significantly greater recall than the liked and disliked music and changing-state speech conditions (all $p < 0.05$). No significant differences were observed between these latter three conditions. Finally, there was no significant position by sound interaction.

Rating scores

Inspection of the mean ratings showed that the liked music condition yielded the highest rating for the likeability and pleasantness properties with the means for the other conditions much lower (see Table 1). However, the difference between the sound conditions was much less, and in a different pattern, for the distractibility and offensiveness properties.

Each property was analysed using a one-way ANOVA. A significant main effect of sound condition was found for all properties: likeability, $F(4, 96) = 118.59$, $MSE = 254.99$, $p < 0.001$; distractibility, $F(4, 96) = 14.12$, $MSE = 77.55$, $p < 0.001$; offensiveness, $F(4, 96) = 15.11$, $MSE = 58.41$, $p < 0.001$ and pleasantness, $F(4, 96) = 57.5$, $MSE = 211.23$, $p < 0.001$. *Post hoc* LSD comparisons revealed that for the likeability rating, liked music was significantly rated more likeable than all the sound conditions and that quiet was rated significantly more likeable than the changing- and steady-state speech and disliked music sound conditions. Similar findings were observed for the pleasantness rating in that liked music was rated as significantly more pleasant than all the other sound conditions and quiet was rated as significantly more pleasant than the steady- and changing-state speech sounds as well as the disliked music condition. With regard to distractibility, quiet was deemed significantly less distracting than all other sounds. Finally, disliked music was rated as being significantly more offensive than all other sound conditions and the liked music was rated as significantly less offensive than the steady- and changing-state speech sounds as well.

DISCUSSION

The beneficial effects of music have been reported in many areas such as enhancing cognitive recovery following a

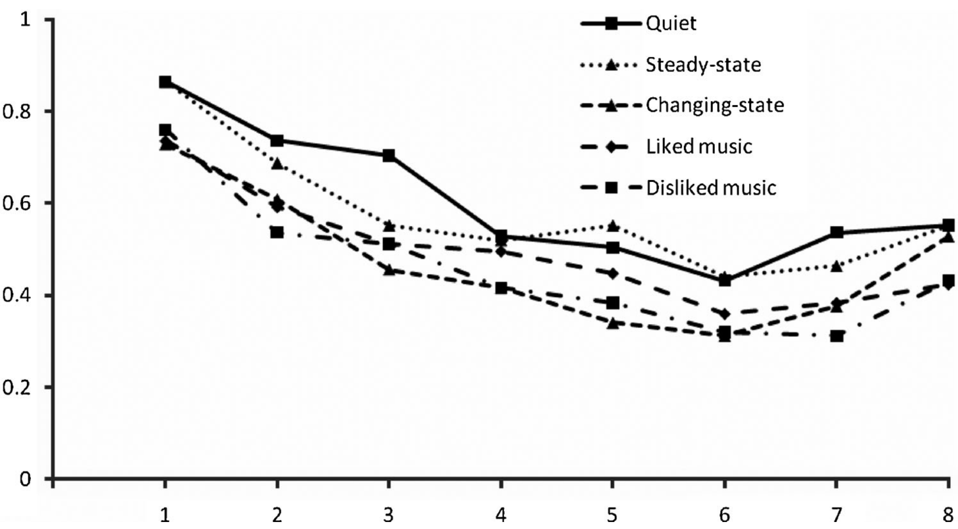

Figure 1. Proportion correct of eight-item serial recall by position and sound condition

Table 1. Mean (and standard deviations of) ratings of four properties (likeability, distractibility, offensiveness and pleasantness) for the five sound conditions

	Quiet	Steady-state speech	Changing-state speech	Liked music	Disliked music
Likeability	5.12 (2.2)	1.56 (.87)	2.44 (1.83)	9.32 (.95)	2.28 (1.34)
Distractibility	3.32 (2.34)	7.4 (2.43)	7.16 (2.76)	7.12 (2.44)	7.32 (2.75)
Offensiveness	2.2 (1.76)	3.92 (2.41)	3.16 (2.13)	1.68 (1.46)	5.56 (2.77)
Pleasantness	4.76 (2.42)	2.24 (2.05)	2.6 (1.91)	8.68 (1.84)	2.28 (1.57)

stroke (Särkämö et al., 2008), alleviating anxiety, depression and pain (Cassileth et al., 2003; Siedlecki & Good, 2006) and improving general cognitive functioning (see Schellenberg, 2005). However, despite research demonstrating that listening to liked music prior to commencing a task can increase performance (*e.g.* Nantais & Schellenberg, 1999; Schellenberg & Hallam, 2005), the positive effect of music preference was not observed in the more common and realistic scenario of listening to music at the same time as task performance. Serial recall performance was approximately equal in both the liked and disliked music conditions as well as in the changing-state sound condition. Further, all three were significantly poorer than the quiet and steady-state speech conditions which did not differ significantly from each other. These findings are consistent with previous work on the irrelevant sound effect (ISE) and suggest limitations on the beneficial effects that music preference may have on cognitive performance.

Interestingly, recall performance was in contrast to participants' own views about the sound conditions. Despite liking and deeming their self-selected music as more pleasant than the other sound conditions, their performance was actually as poor in this condition as in the condition with music that they actually disliked. Furthermore, even though participants rated their choice of music as more likeable than all other sound conditions, they did not feel that it was less distracting. The least distracting sound condition according to the ratings was the quiet condition although it was actually no better, in terms of recall performance, than the steady-state speech condition. However, the lack of expected performance ratings prevents any further analysis or conjecture.

The dominant explanation for music increasing task performance is through changes in arousal and mood (Schellenberg, 2005). When hearing a piece of music that is liked, arousal is raised and performance increases compared to listening to a piece of music that is less liked. This explanation, however, cannot explain the results of the current study as both liked and disliked music conditions showed similar degrees of impairment compared to the quiet, control condition. The fact that both music conditions elicited similar serial recall performance may suggest that both of them increased arousal. However, it would then be predicted that performance would be better, or at least equal to, the quiet condition rather than the observed finding of significantly poorer. Also, given that performance in the changing-state speech condition was not significantly different to that in the music conditions, one would have to argue that a random sequence of digits from 1 to 9 was as arousing as a piece of contemporary music that was either liked or disliked.

These results of the current study are consistent with much research exploring the ISE whereby any background sound that shows appreciable acoustic change between its successive sound items, as the music and the changing-state speech conditions do, will elicit similar degrees of impairment when a task relies upon seriation. Further, sounds that do not exhibit this property, such as the steady-state speech sound, are no more disruptive than quiet (Beaman & Jones, 1998; Jones & Macken, 1993; Perham et al., 2007b).

An alternative explanation for the ISE, and one that may at first be intuitively plausible in the current study, is the attentional capture account. Originally stemming from physiological research, it proposes that stimuli that capture attention do so by causing an orienting response. With regard to the ISE, each irrelevant sound stimulus produces a mental model which is then contrasted with each subsequent sound stimulus. Where the mental model of a previous stimulus mismatches that of a newly-presented stimulus—as is the case with changing-state, and thus the music, conditions—attention is oriented towards the source of the mismatch thus reducing performance on the focal task. According to this explanation, liked music would capture attention, due to its preferential rating and familiarity, compared to disliked music (Cowan, 1995). However, this was not the case as both music conditions showed equivalent performance. Furthermore, the attentional capture account of the ISE has recently been criticised. Firstly, the conception of an orienting response would predict that repeated exposure to the same irrelevant, changing-state items would result in habituation to the ISE, however this has not been observed (Hellbrück, Kuwano, & Namba, 1996; Jones, Macken, & Mosdell, 1997; Perham & Banbury, 2008; Tremblay & Jones, 1998). Secondly, the attentional capture account emphasises the irrelevant sound and not the task, yet it has been shown that the ISE requires the task to involve seriation and when it does not—as in the missing item task and category recall (Beaman & Jones, 1998; Perham et al., 2007a)—then the ISE is not observed.

Other ISE accounts, such as the working memory model and feature model, may well predict the results of the current study by suggesting that the observed interference occurred due to the confusion between to-be-recalled and to-be-ignored items as they all contained speech and thus phonological information (Baddeley, 1986; Neath, 2000). Despite not attempting to negate these potential explanations in the current study as this was beyond the research question, a number of studies do cast doubt on their explanatory power as the ISE is observed regardless of the irrelevant sound containing phonological information (*e.g.* Jones et al., 2000; Jones & Macken, 1993; Perham, Banbury, & Jones, 2005; Salamé & Baddeley, 1989; Schlittmeier et al., 2008).

Another area of research that may speak to the results of the current study is that of mood and memory. This research shows that, in general, mood can impact upon memory in one of two ways (Fox, 2008). Firstly, recall tends to improve firstly, when the mood at encoding is the same as at retrieval (mood-dependent memory), and secondly, and more relevant to the current study, when the emotionality of the recalled information is congruent with the mood of the participant (mood-congruent memory). Given that the to-be-recalled items were devoid of semantic, let alone emotional, content and the mood of participants was not measured, it is difficult to see how mood-congruent memory bias could explain the results of the current study.

The current study adds to a large body of work exploring the beneficial effects of music on cognition with the differences observed between the conditions being consistent the ISE literature. Further, even though the ISE is a laboratory-based phenomenon, the underlying component of the serial recall task—seriation—is a common feature of many everyday tasks and the ISE paradigm is a common situation in which to combine task performance and music listening. Thus, this laboratory-based paradigm can be readily applied to a wide range of more realistic activities. Furthermore, it is consistent with other studies of concurrent music listening and task performance in that performance is generally impaired compared to quiet (Cassidy & MacDonald, 2007; 2009; Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Strbac, 2002). Although this study only demonstrates that serial recall performance does not improve from concurrently listening to liked music, this effect may also be observed for other tasks in which their processing is the same as the processing of the irrelevant sound. For example, reading comprehension would be predicted to be impaired more by vocalised music, compared with to instrumental music, due to a conflict of concurrently processing semantic information in the focal task and in the irrelevant sound (Marsh, Hughes, & Jones, 2008; 2009).

The lack of an effect of music preference on serial recall performance does not negate previous mood and arousal research, however, but rather suggests limitations to the benefits that listening to preferred music can have. A simple subjective decision to listen to a piece of music prior to performing some tasks can increase performance. However, listening to that same music whilst performing those same tasks, has the opposite effect and impairs performance. Interestingly, the effect of listening to liked or disliked music before commencing an ISE study is yet to be explored and may provide further information regarding music on cognitive performance.

The findings of the current study may have implications for studying skills in which students typically revise for examinations whilst listening to music. If their revision processes rely upon remembering information in sequential order, such as the order of elements in the periodic table or the series of steps to follow to solve a mathematical problem, then playing their choice of music in the background will make it more difficult for this sequence to be recalled as the music will, more than likely, contain changing-state speech information. Then again, listening to music that they do not like will not be any worse compared to liked music. Further, given that language-learning is underpinned by seriation, playing music whilst children are learning their first language may have a negative effect (Saffran, 2002).

Future research could explore music preference in more detail by examining the characteristics that influence music choice. That is, music that is perceived to be happy is generally fast in tempo and played in a major key, whereas sad music is slow in tempo and played in a minor key (Schellenberg, Peretz, & Viellard, 2008). If the preferred sad music contains less changing-state information due to its slower tempo, it may more closely resemble steady-state sound and thus not produce an ISE.

In sum, a simple irrelevant sound study has demonstrated that preference for concurrent background music does not differentially affect serial recall performance—both liked and disliked music are equally disruptive. What is important in this particular paradigm is the changing-state nature of the sound. However, these findings do not undermine the performance-enhancing effects of listening to music although they do suggest some limitations in terms of their generalisability.

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