DURMS
Durham Undergraduate Research in Music & Science

The Effects of Background Music on Non-Verbal Reasoning Tests

Rhiannon Bailey
Durham University

ABSTRACT

This study examined the effects of background music on non-verbal reasoning (NVR) tests. Forty participants completed the Coordination Group Publications (CGP) 11+ NVR test, a form of cognitive test, in two conditions: music and silence. The participants were split into four sub-groups, each with a different musical stimulus: either Arabic, Buddhist, Michael Jackson or Mozart. The hypothesis for this study was that participants would see improved NVR performance whilst listening to Mozart or Buddhist music but a detrimental effect whilst listening to a Michael Jackson or Arabic song. Angel, Polzella and Elvers (2010) and Cockerton, Moore and Norman (1997) showed that Mozart and Buddhist music respectively had positive effects on cognitive tasks, forming the basis to the first half of the hypothesis. Belsham and Harman (1977) suggested that music with lyrics would have detrimental effects, forming the second half of the hypothesis. The hypothesis was not fully supported because participants listening to Michael Jackson answered more questions and more questions correctly than in silence. Overall, whilst listening to Buddhist music, participants answered more questions and more questions correctly than in silence. However, when comparing students with non-students and musicians with non-musicians, it was found that there were differences between the groups in terms of which musical stimuli were associated with improved NVR performance. Exceptionally, Michael Jackson improved performance for all sub-groups.

1. INTRODUCTION

With technology constantly improving, background music is becoming a more and more prominent feature of everyday life. But is this background music making us more or less productive? Many students claim that they can study effectively with the presence of background music (Patton, Stinard and Routh 1983). However, despite numerous studies focusing on the effects of background music on performance tasks, the findings are still inconsistent (Schellenberg and Weiss 2013). Sogin (1988) suggested that background music had no effect on task performances (hand/eye coordination problems) because the music can be simply ignored. On the other hand, Angel *et al.* (2010) have suggested that background music increases the speed of spatial processing (they used music composed by Mozart). Furthermore, Cockerton *et al.* (1997) showed that participants answered more questions and more questions correctly whilst completing cognitive tasks and listening to Buddhist Zen background music. Hilliard and Tollin. (1979) suggested that familiarity with the music improved comprehension performance. The neurological research by Besson, Faita and Peretz. (1998) suggested that lyrics and melodies are processed independently in the brain, thus lyrics creating another aspect for the brain to focus on. Therefore, music with lyrics would have a detrimental effect on performance (Belsham and Harman 1977). Jones, Miles and Page (1990) claimed that speech has a detrimental effect if it is meaningful. Therefore, it is likely that meaningful lyrics are more detrimental than unintelligible lyrics. Thompson, Schellenberg and Letnic (2011) suggested that fast and loud music disrupts reading comprehension (they used adapted Mozart sonatas). Speer (2011) proposed that those who believed music was distracting were more distracted and vice versa, indicating that the participants could recognise their productivity levels. However, Anderson and Fuller (2010) suggested that the results of those who preferred working with music were more detrimentally affected than those who preferred working in silence. This is merely a glimpse into the complications of this area of study. All studies that focus on the effect of music on a performance task have been grouped together under the title of 'the effects of background music', but background music studies are full of many different factors: participants, tests, testing conditions, and musical stimuli (with each individual song or piece having a different characteristic which could be the cause of enhancing or impeding performance). As far as I am aware, there are no studies that use the same tests so cross-referencing between the studies causes many conflicting results. Therefore, to help focus this area of study, I believe that some of these factors need to be solidified. Naturally, it is difficult to use the same participants for different studies as this would require a few people to be tested under many conditions which would not be temporally feasible. However, I propose that it would be worthwhile to split 'background music' studies into groups that use the same tests, to make sure that the same area of the brain is being used. Then, it would be appropriate to compare results between the different musical stimuli to see if different types of music have a different effect on performance tasks. It is also important to note the participants used because if one study only tests British students, whilst another tests Chinese adults, the findings are likely to be inconsistent, due to their upbringing. However, if they used exactly the same test, then the findings can be more accurately compared. In this study, I have used the same tests for all participants and the

same conditions so that the results from different musical stimuli can be cross-referenced. The hypothesis for this study is that participants will see an improved performance whilst listening to Mozart or Buddhist music as Angel and Cockerton suggested, but a detrimental effect whilst listening to an Arabic song or Michael Jackson song, as Belsham and Harman suggested.

2. METHOD

Design. The experiment employed an independent measures design, with four conditions, one for each musical stimulus. The independent variable of this study was the music stimulus and the dependent variable was the number of questions answered, and the number answered correctly.

Participants. Forty participants (22 women, 18 men), whose ages ranged from 19 to 63 years (M = 29.23 yrs.), participated in this study. The participants were split into four groups of ten, each group completing the task to a different musical stimulus. 87.5% of participants were British. The participants were mostly students and all volunteers. Two participants recorded having hearing impairments. Their results have been kept as their results link to Sogin's (1988) theory, which is discussed below.

Materials. The question booklet used was the CGP 11+ Non-verbal Reasoning Practice Book Assessment Test 1 (Eleven Plus Exams n.d.). This style of question was used because it tests general intelligence and does not depend on pre-learned intelligence (National Foundation for Educational Research n.d.). The questions asked often rely on spotting patterns in a sequence or common features between unusual shapes.

The musical stimuli used were:

Michael Jackson (MJ) - *Man in the Mirror* (jennifer95828 2008),

Arabic (A) - Shiraz's *Kif Badak 3ani Tghib* (starting at 00:50) (LifeStylezStudios 2015)

Mozart (M) - Mozart's *Piano Sonata in C major, K. 545* (Liu 2015)

Buddhist (B) - *Japanese relaxing songs* (Vibe 2015)

S – Silence

These pieces were chosen because they all lasted for at least five minutes, so no stimuli had to be played multiple times which could have affected the results. The Mozart and Michael Jackson pieces were chosen for their familiarity and the other two for their unfamiliarity. No participants could speak Arabic, so the lyrics were unintelligible to all ten participants that had that stimulus. All of the stimuli were played through Youtube from the beginning of the video (unless otherwise stated) but the participants were not able to see the laptop screen to reduce other distracting elements. The musical stimuli were played through a laptop at 40% volume, one meter away from the participant, measuring an average of 55 dB over the five minutes. This was to replicate the average conditions of background music in the home or office. The information sheet and consent form, and the questionnaire (about musical background, age, gender, hearing impairments, nationality, familiarity with the stimulus and occupation) were all uniquely designed for this experiment.

Procedure. Participants completed the task individually and under my supervision. All experimental testing took place in the same room, with outside noise kept to a minimum. Participants were given an information sheet and consent form to complete before the study started, although they were initially unaware of the purpose of the study. They were then given an instruction sheet and example questions and prompted to ask if they had any questions. They then completed the NVR test in two five-minute sections. One five-minute section was in a silent condition and the other was accompanied by one of the musical stimuli. The question booklet was the same for each participant. To account for practice effects and slightly different style of tests throughout the booklet the order of the conditions and stimuli was randomised. The participant completed as many questions as possible during the first five minutes under the first condition. They were then allowed a two minute break if desired (but none of these participants used this break). The next five minutes were in the opposite condition to the first section (music or silence) and the participant carried on through the question booklet, carrying on from where they left off in the first section. After the second five-minute section, the participant completed the questionnaire and then were debriefed

3. RESULTS

Participants were scored by the number of answered questions and the number of correctly answered questions. Across all four conditions, participants answered a mean of 5.23 questions correctly out of 10.2 questions answered whilst listening to music (52.53%) and 5.13 questions correctly out of 9.28 questions answered whilst in silence (54.29%). This is only a difference of 1.76% but looking closer into the results, more meaningful conclusions can be drawn.

By separating the results into the different stimuli groups, it can be seen that participants answered more questions correctly compared to their silent condition under the Arabic, Buddhist and Michael Jackson conditions, as shown in Figure 1. However, under the Mozart condition, participants answered fewer questions correctly but as a percentage of questions answered, there was no difference between the two conditions, as shown in Figure 2. This graph also shows that for the Arabic condition, a greater

percentage was correct in the silent condition, showing that participants worked slower but more accurately when not listening to the Arabic music.

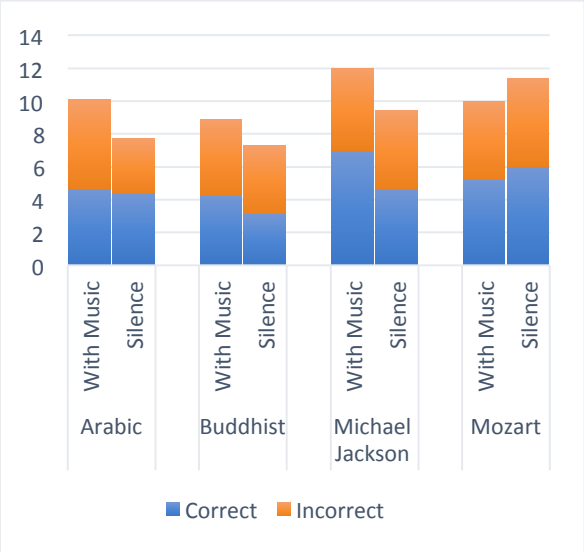

Figure 1. Mean number of correct and incorrect answers by musical stimulus

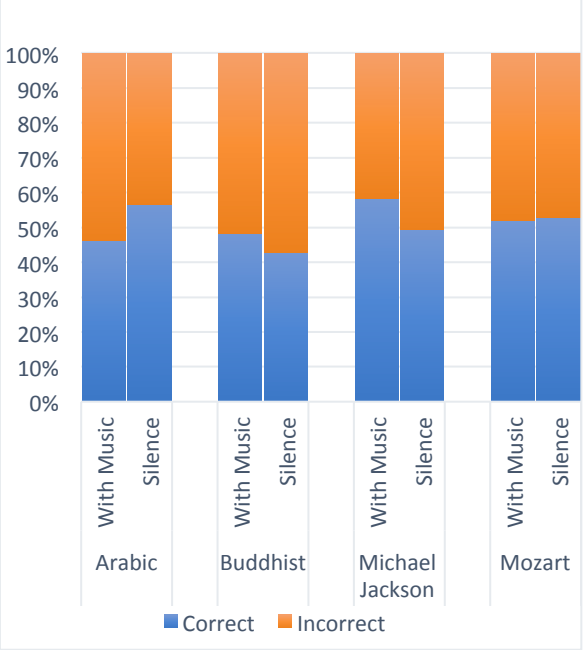

Figure 2. A graph to show the mean percentage score of the participants

Because many of the previous studies only considered one group difference (e.g. students versus non-students, or musicians versus non-musicians), I have compared the results between these two groups to see if there is any difference that previous researchers would have missed by only testing one sample group.

As shown in Figure 3, students (25 participants) who completed the NVR test whilst listening to the Arabic music performed visibly worse than in silence, whereas non-students (15 participants), shown in Figure 4, performed better whilst listening to Arabic music than in silence. The non-students had a wide range of occupations and aged between 27 and 63 (M =42.33). It was, however, the opposite for the Buddhist and Mozart conditions.

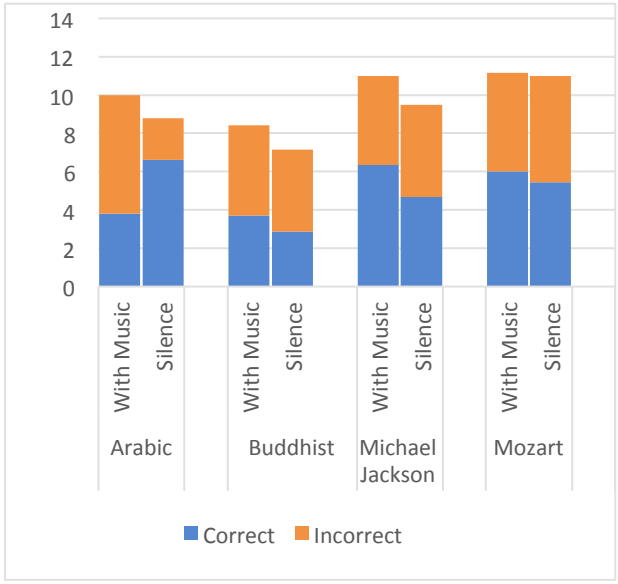

Figure 3. A graph to show the mean number of correct and incorrect answers of students

For the Michael Jackson condition, both groups performed better whilst listening to Michael Jackson, but non-students made observably fewer errors whilst in silence than students. Musicians and non-musicians also displayed contrasting results, as seen in Figures 5 and 6.

Although only 13 participants classed themselves as musicians, the results were very similar when I analysed all the participants (22 participants) who could play at least one instrument to a standard of grade 5 or above (Appendix 1), but with a slight increase with number of correct answers in the silent Mozart condition.

Comparing these graphs shows that musicians perform better whilst listening to the Arabic stimulus and Michael Jackson stimulus. They answered more questions whilst listening to Mozart but the same amount of correct questions, meaning that they have a higher percentage of correct answers whilst in silence. Whilst listening to Buddhist meditation music they answered fewer questions

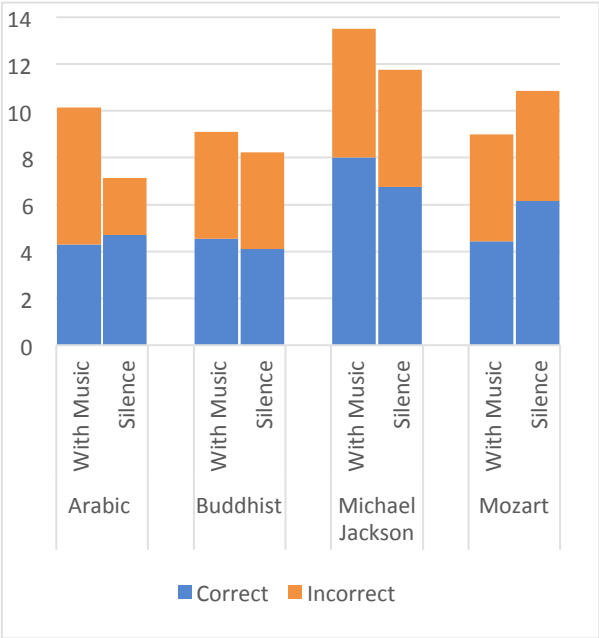

Figure 4. A graph to show the mean number of correct and incorrect answers of non-students

correctly. However, the non-musicians answered fewer questions correctly whilst listening to Arabic music and Mozart, but a fraction more questions correctly whilst listening to Buddhist music or Michael Jackson. Therefore, apart from the Michael Jackson stimulus, there were clear differences between the groups in terms of which stimuli were associated with better performance on the NVR tasks.

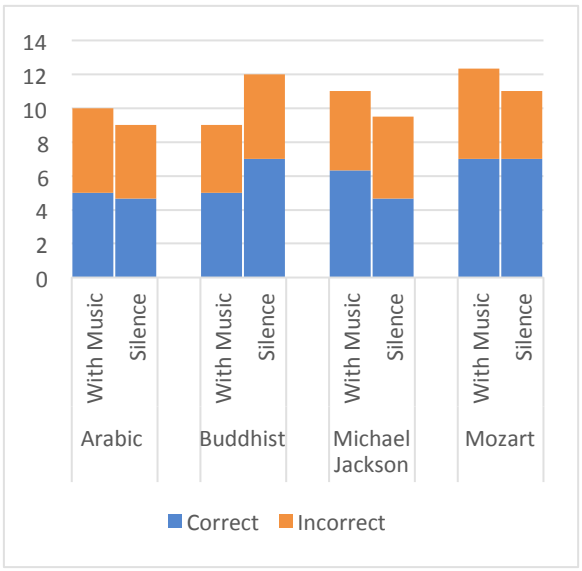

Figure 5. A graph to show the mean number of correct and incorrect answers of participants who described themselves as musicians

Overall, the only stimulus that consistently aided performance compared to the silent condition was the Michael Jackson track. Michael Jackson's song scored the highest mean familiarity rating: 4.3 out of 5 (range: 3 to 5). However, Mozart's *Piano Sonata* was the next most familiar piece, with a mean of 2.3 out of 5 (range: 0 to 4) but this piece only improved the performance of students. However, students rated their familiarity with this piece at 1.83, compared to non-students rating it at 3, out of 5.

4. DISCUSSION

These results show that by combining all the participants and stimuli together, less than 2% difference is shown between the music condition and silence condition. This is an important finding for situations like the office, where a radio is often played, consisting of a mixture of styles (as participant NN described in their questionnaire). It would suggest that this background radio does not enhance, nor negatively affect NVR performance. This could support Sogin's (1988) theory that music and silence do not affect performance differently because people block out background music. However, the two participants who reported blocking out the music were also the participants who reported partial hearing impairments, so this could have made it easier for them to block it out. Furthermore, 38 of the participants had a belief of whether they performed better with or without music. 27 of these were correct in their judgement. This does not support Sogin's theory as only two claimed to block out the music and those who were aware of the music generally correctly identified whether it was helping or hindering their performance.

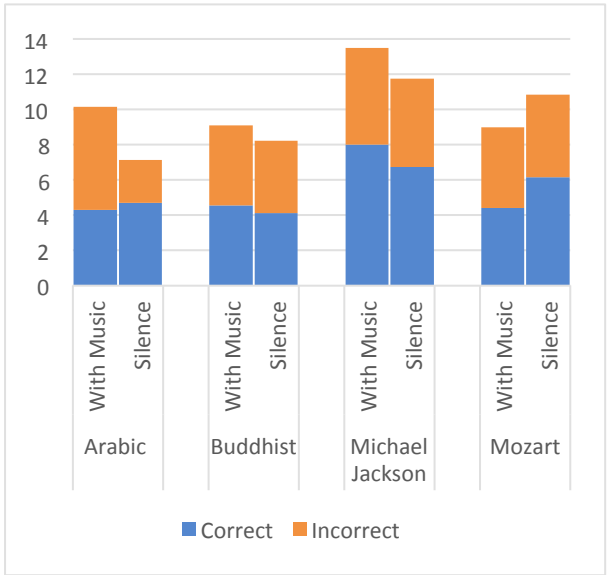

Figure 6. Mean number of correct and incorrect answers of participants who described themselves as non-musicians

Once these stimuli and participants are split up into separate groups, more specific conclusions can be drawn.

Separating the musical stimuli, but keeping all 40 participants, shows that the Buddhist and Michael Jackson stimuli aided the performance of the participants. This partially supports the hypothesis as Buddhist music was expected to improve results, but surprisingly the Mozart condition hindered performance. Cockerton *et al.*'s (1997) claim has therefore been replicated as, whilst listening to Buddhist music, participants answered more questions and more questions correctly than in silence. Although the Arabic condition did partially aid performance, the difference is so small (0.29) that it cannot be classed as a significant difference. Additional data collection would allow us to determine if this difference can be observed reliably throughout a larger sample. The Michael Jackson condition also did not support the hypothesis as it enhanced performance. This could suggest that Hilliard's (1979) familiarity theory was more applicable than Belsham's (1977) lyrics theory (Michael Jackson rated the most familiar out of all four stimuli). However, Mozart's piece was the next most familiar and did not consistently aid performance.

Furthermore, the only section where Mozart did improve results was in the students' results, but they rated the music as less familiar to them than the non-students. Angel *et al.*'s (2010) claim has therefore not been supported as participants answered less questions whilst listening to Mozart than in silence. Furthermore, Thompson *et al.*'s (2011) claim has not been supported as the Mozart sonata had the fastest bpm (130) compared to the Arabic and Michael Jackson stimuli that were both 100 bpm (the meditation music had no concrete beat). Therefore, the tempo of Michael Jackson's song was not the reason for it stimulating NVR performance.

The main difference between the Michael Jackson stimulus and the other stimuli is the presence of understandable lyrics. This song has very uplifting and motivating lyrics and it could be due to this that participants performed better whilst listening to it. Further research would need to be done, comparing motivating, neutral and demotivating lyrics, to see if there is a relationship between the nature of the lyrics and the results achieved. Furthermore, the songs would need to be of equal familiarity to control the test. The familiarity could mean that the participants were better at ignoring the music as they were aware of how the song evolved.

Although listening to Michael Jackson improved performance of all sub-groups, the other stimuli produced opposite results between the groups (students and nonstudents, and musicians and non-musicians), making it difficult to say whether the stimuli supported the hypothesis overall or not. But this does show how comparing studies with different participant samples is not appropriate. There were too few participants to test the difference between British and non-British (or another specific nationality) but this could have also shown interesting results because of the different upbringings that these people would have had. Upbringing could also account for other aspects of these results, for example musicians may be used to listening to a variety of music whilst working which could be the reason why they performed better whilst listening to music (excluding the Buddhist Zen music as this could be considered more of a religious, trance enhancing sounds rather than a musical piece). This would support Hilliard's (1979) theory that familiarity leads to an improved performance. Furthermore, individual differences could be the reason for differing results, such as personality and general intelligence. A more intelligent person may be able to focus on the task in hand with a higher level of distraction for example, or a more shy person may like the comfort of having background music playing whilst working. Therefore, further research would be needed to help eliminate some of these external factors.

One limitation of this study is that some participants found section 2 easier than section 1, or vice versa. I included differing sections to reduce the chance of practice effects or boredom from completing the same style of questions or ten minutes, but they were intended to be the same difficulty. Unfortunately, it is not recorded who found each section easier (it was only commented by participants at the end of the study) as this may have had a more significant effect than that of the background music. There was no overriding consensus on the relative difficulty of the sections, so I have not adjusted these results. Indeed, the randomised order of the stimuli should have counteracted any order effects. In further research, it would be beneficial to do a pilot study to ensure that the different test sections are of the same difficulty. Ideally, for this type of testing, repeated measures would be used as this would provide a more accurate result, but because the participants could not be given a monetary reward for their participation, it would have been difficult to find enough participants willing to provide more than an hour of their time. Furthermore, practise and fatigue effects may have been seen, which would affect the results.

Another limitation of this study is that the sub-groups (students, musicians etc) are not equal due to the randomised order of participants and stimuli. Future research would benefit from pre-organising the stimuli and participants to create equal numbers in each sub-group, although this could prove difficult due to the overlap between sub-groups. This study has shown the effects of these four musical stimuli on NVR performance. The most prominent finding suggests that Michael Jackson's *Man in the Mirror* is the most effective for improving NVR performance. This is likely to be because of the participant's familiarity with the music but could also be due to the motivating lyrics. Given more time for this project, it could have been worthwhile to do a preliminary

study to find out the most well-known and unfamiliar pieces. However, as discussed in this report, there are many different characteristics of both the music and the participants that could affect performance. Therefore, for further research, it would be beneficial to conduct a longitudinal large-scale study which involves using the same test and controls as many other variables as possible. This study would have to be repeated to test each variable. Such a large-scale study would contribute significantly to this area of research and would be more applicable to the general public. Naturally, this is beyond the scope of an undergraduate study but would be more feasible with substantial funding.

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Appendix 1 – Mean NVR scores of participants who could play at least one instrument to at least grade 5 (or 'advanced') standard or above.