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Dolegui, A. S. (2013). "The Impact of Listening to Music on Cognitive Performance." *Inquiries Journal/Student Pulse*, *5*(09). Retrieved from http://www.inquiriesjournal.com/a?id=1657

The Impact of Listening to Music on Cognitive Performance

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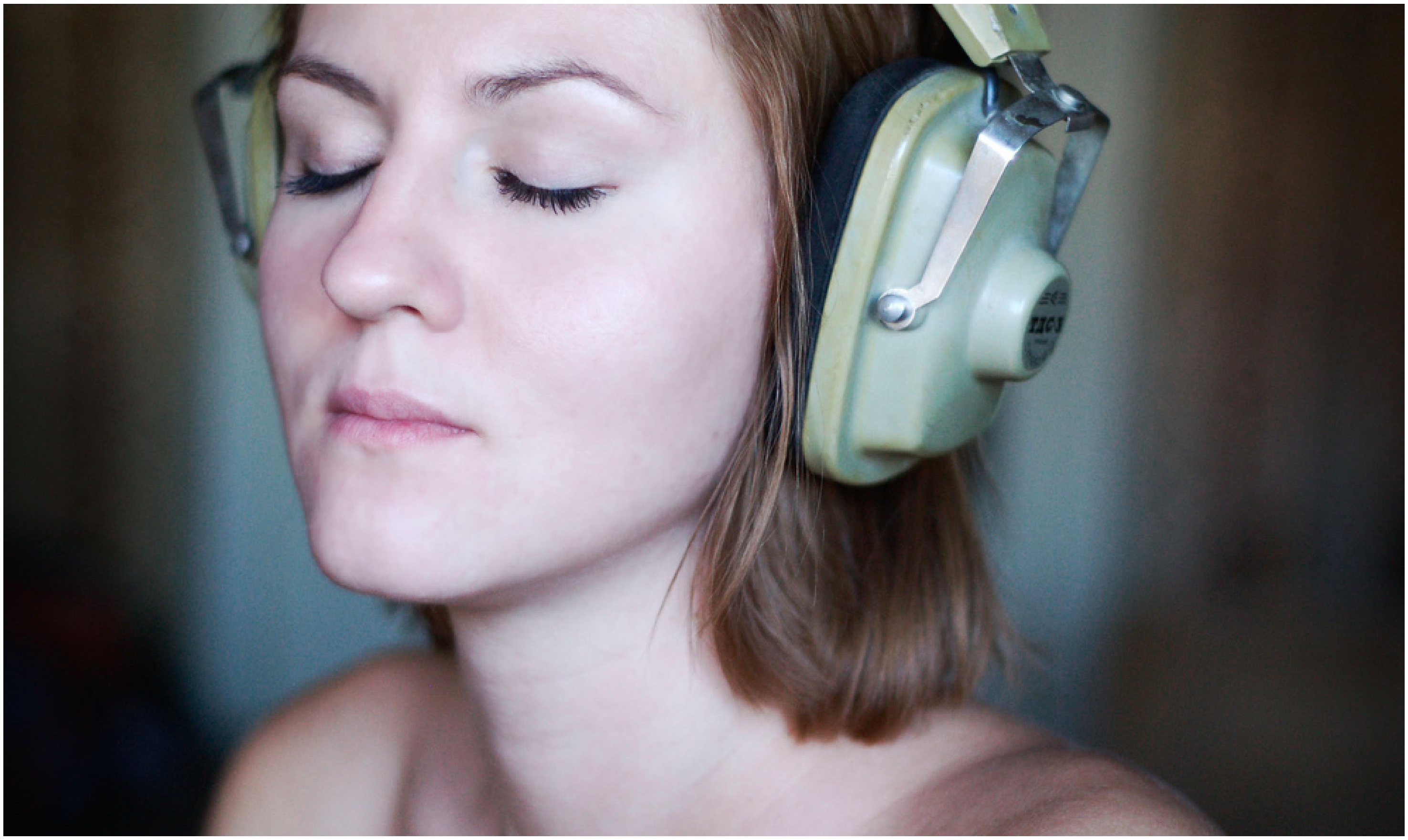
2013, Vol. 5 No. 09

Abstract

Listening to music for relaxation is common among students to counter the effects of stress or anxiety while completing difficult academic tasks. Some studies supporting this technique have shown that background music promotes cognitive performance while other studies have shown that listening to music while engaged in complex cognitive tasks can impair performance. This study focuses on the impact different genres of music, played at different volume levels, have on the cognitive abilities of college students completing academic tasks.

Many students listen to music to alleviate the emotional effects of stress and anxiety when engaged in complex cognitive processing, such as studying for a test, completing homework assignments, or while reading and writing. This practice is so common that it would be beneficial for college students to understand the role that music plays on cognitive performance. Research demonstrating the effects of music on performance is well documented, but have shown ambiguous evidence on this matter. In studies conducted to learn about the effects of musical distraction on cognitive task performance, the findings have demonstrated the idea of music improving cognitive performance (Cockerton, Moore, & Norman, 1997), but there has also been research contradicting those results, where music was found distracting for participants performing cognitive tasks (Furnham & Bradley, 1997). However, with the plethora of music genres available to music listeners, it is important to understand how different types of music impact performance. Additionally, very few studies address the interaction between the intensity or volume of the music played and its effect on cognitive processing. The present study aims to understand the effect of listening to different genres of music played at different volume levels on cognitive task performance.

Many students choose to listen to a preferred genre of music when they study or do their homework without understanding the potential harmful effects of such practice. A study conducted by Smith and Morris (1977) addressed this question by studying the effects of sedative and stimulative music. The study focused on the influence these two distinct genres of music have on performance, anxiety, and concentration. Participants had to indicate their preferred genre and were requested to repeat a set of numbers backwards while listening to either the stimulative, sedative, or no music. The results indicated that participants performed worse while listening to their preferred type of music. Additionally, in the no music condition, participants performed best. These results indicate that a preferred type of music can serve as a distracting factor when one is engaged in a cognitively demanding task perhaps due to the fact that less cognitive resources are available when the attention is drawn to the lyrics, emotions, and memories that such music can evoke. Participants who listened to sedative music performed better than participants who listened to simulative music and worse than those who listened to no music at all. These results indicated that stimulative music is a stronger distractor and obstructs cognitive processing more than sedative music does.



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The influence of music on cognitive performance has also been linked to personality types. A study conducted by Furnham and Bradley (1997) illustrated pop music as a distracter on the cognitive performance of introverts and extraverts. They predicted that extraverts would outperform introverts in the presence of music. The participants were required to perform two cognitive tasks: a memory test with both an immediate and a delayed recall and a reading comprehension test. The two tasks would be completed in the pop music condition as well as in silence. The results determined that immediate recall on the memory test was severely impaired for both introverts and extraverts when the pop music was played. In the delayed recall component of the memory test, introverts showed significantly poorer recall than did extraverts in the pop music condition as well as introverts in the silent condition. Also the introverts' performance on the reading comprehension task in the pop music condition was impaired when compared to extraverts in the same condition and to introverts who performed the task in silence. Overall, the researchers determined that pop music served as a distractor for the cognitive performance of both extraverts and introverts; however, introverts seemed to be most affected. Interestingly, this study revealed some evidence that overall background noise, such as television, music, and chatter could improve performance in complex cognitive tasks for extraverts, although it will significantly impair introverts' performance (Furnham & Bradley, 1997).

Studies involving noise as a distraction have demonstrated the same ambiguous results regarding their effect on cognitive processing as studies involving background music. Dobbs, Furnham, and McClelland (2011) conducted a study that tested the effect of distracters, specifically background noise and music, on cognitive tasks for introverts and extraverts. The researchers hypothesized that performance, for both introverts and extraverts, would be worse in the presence of music and noise than it would be in silence; specifically, for all the cognitive tasks, performance would diminish in the presence of background noise, improve with only background music, and be optimal in silence. The findings supported their predictions and showed that cognitive performance in silence was better than performance with background music, which in turn was better than performance with background noise. The results also demonstrated that, overall, performance in silence was best when compared to performance in background noise and music (Dobbs, Furnham, & McClelland, 2011). In contrast, a study conducted by Pool (2002), monitored the distracting effects of background television on homework performance and did not find any significant impairment on homework assignments when students were distracted by television while working on those assignments. These findings indicate that background noise, just like background music impacts cognitive performance in ways that have not been fully understood by researchers.

Although previous research has established that music can either distract or facilitate cognitive task performance, improved performance in the presence of music might be directly related to the type of music listened to (Cockerton, Moore, & Norman, 1997). A study conducted by Hallman, Price, and Katsarou, (2002) supported this argument. In fact, they tested the effect of calming and relaxing music on arithmetic and memory performance tests in children ranging from ages ten to twelve. They found better performance on both tasks in the calming and relaxing music condition when compared with a no-music condition. They also tested these children in an arousing, aggressive, and unpleasant music condition, and the results showed that their performance on both tasks was heavily disrupted and led to a lower level of reported altruistic behavior by the children (Hallman, Price, & Katsarou, 2002). Although these data did not find that calming music enhanced performance, one might imply that this type of music can provide a soothing environment that puts students at ease, facilitating cognitive processing.

The present study considers the effects of two different types of music at varying intensities on cognitive task performance and compared them to tasks performed in silence. It was predicted that tasks performed in silence would yield better results than tasks performed both in the soft music and the loud music conditions, demonstrating that music is a distracter to cognitive performance. Additionally, performance scores were expected to be significantly lower in the presence of loud music at a high intensity, suggesting that both the type of music and the volume at which the music is played are contributors to the distracting effect of music. Finally, performance was predicted to be significantly higher in the presence of soft music compared to loud music.

Methodology

Participants

Thirty-two undergraduate students (twenty-five females, seven males), ranging in age from 20 to 41 years from the University of Maryland, Baltimore County (UMBC) at Shady Grove participated in this study. Participants were selected from a psychology class and received extra credit for their participation as agreed on by the class's instructor. All students participated on a voluntary basis.

Materials

This study used five different arithmetic tests to measure cognitive performance (Appendix A). The tests consisted of 20 different operations: 5 multiplication, 5 division, 5 addition, and 5 subtraction problems. The order of operations was randomized throughout the tests. No question involved operations with more than a three-digit number. The five tests were similar in difficulty. Loud music was defined as heavy-rock metal music, and the song used in that condition was "Not Ready to Die" (Demon Hunters, 2004). Soft music was defined as classical piano-only music, and the piece that was used in that condition was "Morning Light" (Beeson, 2004).

Procedures

The study was conducted in rooms assigned by the University of Maryland, Baltimore County (UMBC) at Shady Grove. Participants were given informed consent forms to fill out at the beginning of the experiment and a research participation credit sheet. A repeated-measure design was used in this study. All thirty-two participants were exposed to all five conditions. The researcher explained to participants that music would be played while they solved the questions on the tests. The volume at each music condition was adjusted as the experiment progressed.

The participants were asked to solve five arithmetic tests with twenty different questions on each test. The first test was conducted in the soft music condition at low intensity (Test 1- SM-LO), and the second test, in the loud music condition at low intensity (Test 2-LM-LO). The third test was performed in complete silence (Test 3- SIL). The fourth and fifth tests were conducted in soft music and loud music conditions, respectively, both at high volume intensity (Test 4-SM-HI and Test 5 LM-HI). The participants were allowed sixty seconds to complete each test. There was a twenty second waiting period between each test. The participants were not allowed to use a calculator or any other electronic device to complete the questions on the tests.

Results

This study was conducted in a repeated-measured design; therefore, a paired sample t-test was used for the analysis. An alpha level of .05 was used for the analysis. The independent variable was the type of music played at two different levels of intensity: high intensity and low intensity. The dependent variable was the performance score, which was measured in terms of accurate answers obtained in each of the tests. The tests were not graded for completion but for accuracy only.

In agreement with the first hypothesis, performance scores were significantly higher in silence (M= 12.94) than in all four music conditions, intensity levels, and types of music combined (M= 11.99), $t(31)$= 2.21, p <.05. The second hypothesis was also supported in the study; participants obtained significantly higher test scores at low intensity (M= 25.63) than at high intensity of both types of music (M= 22.34), $t(31)$= 4.75, p <.001. Performance scores were also significantly higher in silence (M= 12.94) than in loud music at high intensity (M= 10.78), $t(31)$ = -2.90, p< .05.

However, there was also no significant difference in test scores between participants in the soft music conditions (M= 23.75) and performance in the loud music conditions (M= 24.22), $t(31)$= -0.56, p= 0.582.

Discussion

The present study sought to demonstrate the impact of different genres of music played at different volume levels on cognitive performance. In accordance with the first hypothesis, participants performed better in silence than they did in any music conditions. The findings were also in agreement with the second hypothesis. They demonstrated that the performance was significantly worse in the presence of loud music at high intensity. Contrary to the third hypothesis, however, there was no significant difference between the type of music that was played and performance scores. The scores were not significantly higher in the soft music versus the loud music condition. Interestingly, there was no difference when the scores from the soft music at high intensity were compared to scores from the loud music at high intensity.

These results seem to parallel those of Smith and Morris (1977). In their study, they also found that participants performed better on a cognitive processing test while listening to no music than they did while listening to either stimulating or sedative music. They determined that performance is impaired with music and optimized with no music. However, their study revealed that participants performed significantly better while listening to sedative music than they did while listening to stimulating music, whereas the current experiment found no significant difference in test scores between the loud music and soft music conditions.

The third hypothesis suggested that performance would be better in the soft music condition when compared to the loud music condition because it was believed that classical music would provide a positive, soothing, and comfortable environment for the participants due to its relaxing tone that will facilitate information processing. However, that hypothesis was not supported by the results; it is important to note that the overall performance was significantly lower in the loud music at high intensity. Based on these results, the presence of lyrics and the consistent use of louder instruments, such as drums, bass and, electric guitar to the heavy metal rock music can be seen as reasons for its distracting effects.

Interestingly, while the findings of this study revealed that it is the intensity of the music rather than the type of music that matters the most when it comes to cognitive performance, it is still noteworthy to point out that scores were significantly higher when participants completed the tests in the silence condition. Through this process, it can be implied that it is easier to process information in the presence of a minimal level of distraction. It can be implied that students should not listen to any music or allow any auditory disturbance while studying to obtain maximum performance level. Students should strive to study and learn in an environment such as the library or a private study room that is as quiet as possible, especially when the material requires higher cognitive processing.

The sample size was the major limitation of this study. Although two of the predictions were supported with this sample, large samples could have provided more reliable significances that could be generalized to the college student population. Due to the limited availability of participants, this study was conducted in a repeated-measured design, which could also be a limiting factor. The sequence in which the tests were given was not randomized throughout the experiment; as such, learning effects could account for the improvement in later tests as the study progressed. Future research should strive to change the sequence in which the tests are administered to guarantee that the results obtained are those of the treatment effects and to eliminate or reduce possible learning effects.

The design of the room could also be another limitation to this experiment. Where participants were seated in the room could have had an effect on how the music was heard. Hence, for participants sitting closer to the speakers, the music was louder than those who were sitting on the other side of the room. This variance in volume level may have either positively or negatively affected the results. Although, some of the results from this study showed that the arithmetic problems were a sufficient tool to assess cognitive performance; however, they may have been too simple for students on the collegiate level to perform. Besides, there were no mathematical base level assessments conducted prior to the study. Participants with stronger skills could have had a biased advantage, whereas those with lower mathematical skills would have had a biased disadvantage. Future research should plan to design more complex cognitive processing tests, such as memory tests or reading comprehension questions from standardized tests like the GRE or the SAT. This could provide a more accurate depiction of the participants' cognitive processing abilities.

Results from the current study demonstrated how important it is to consider the effects of distracting music on cognitive performance. It was shown that the volume plays a crucial role and could be more important than the type of music played. However, data from this study has demonstrated that silence seems to be the best environment to maximize performance when engaging in cognitive activity. Classical music was not shown to enhance performance contrary to the study's expectations. Hence, the direct benefits of listening to music on cognitive processing could be more of a fantasy than a reality.

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Appendix

TEST 1- SM- LO	TEST 2 – LM- LO	TEST 3-SIL	TEST 4- SM-HI	TEST 5– LM-HI
1. 9+9 =	1. 8+9 =	1. 6+7 =	1. 5+6=	1. 7+9 =
2. 11-8 =	2. 13-8 =	2. 12-7 =	2. 11-7 =	2. 41-7 =
3. 21÷7 =	3. 21÷3 =	3. 24÷4 =	3. 26÷2 =	3. 36÷2 =
4. 12 x 3 =	4. 12 x 3 =	4. 11 x 5 =	4. 9 x 5 =	4. 9 x 3 =
5. 8+13 =	5. 8+14 =	5. 7+15 =	5. 6+17 =	5. 5+19 =
6. 81÷9 =	6. 35÷5 =	6. 35÷5 =	6. 40÷5 =	6. 20÷5 =
7. 35-7 =	7. 25-7 =	7. 26-9 =	7. 27-9 =	7. 28-9 =
8. 4 x 7=	8. 4 x 6=	8. 8x7 =	8. 6 x 9 =	8. 9 x 9 =
9. 64÷8 =	9. 24÷8 =	9. 34÷2 =	9. 54÷2 =	9. 48÷4 =
10. 27+9 =	10. 17+7 =	10. 18+7 =	10. 19+9 =	10. 18+8=
11. 10-2 =	11. 13-5 =	11. 14-5 =	11. 16 -9 =	11. 17 -9 =

12. 9 x 6 =	12. 9 x 4 =	12. 7 x6 =	12. 8x6 =	12. 8x7 =
13. 18 ÷6 =	13. 18 ÷3 =	13. 18 ÷3 =	13. 32 ÷4 =	13. 32 ÷8 =
14. 6+9 =	14. 16+7 =	14. 26+9 =	14. 25+9 =	14. 15+9 =
15. 7 x 8 =	15. 31-6 =	15. 21-6 =	15. 31-6 =	15. 31-4 =
16. 32-6 =	16. 7 x 7 =	16. 4 x 9 =	16. 7 x 9 =	16. 7 x 5 =
17. 48 ÷8 =	17. 36 ÷6 =	17. 49 ÷7 =	17. 49 ÷7 =	17. 28÷7 =
18. 5 x 7 =	18. 8 x 7 =	18. 7 x 3 =	18. 8 x 9 =	18. 9 x 4 =
19. 8 + 6 =	19. 9 + 8 =	19. 6 + 9 =	19. 19 + 7 =	19. 29 + 8 =
20. 22-8 =	20. 21-6 =	20. 19-8 =	20. 38-9 =	20. 36-9 =