INFLUENCE OF DIFFERENT MUSIC GENRES ON LEARNING PROCESSES

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INFLUENCE OF DIFFERENT MUSIC GENRES ON LEARNING PROCESSES: RANDOMIZED CONTROL TRIAL

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Contents

1. Introduction

1.1 Music and Learning

Music is a universal aspect of human culture that connects various areas of our lives, from moments of leisure and entertainment to the realms of education and cognitive development. It influences our mood, behaviour, and emotions which are deeply intertwined with our learning experiences and academic performance. In everyday life, music serves as a tool we use to enhance the experiences we have, express our feelings, and evoke vivid memories. But music is different for everyone, often depending on the rhythm, beat, tempo, and harmonic structure. It is for the individual to choose and welcome certain musical genres that they enjoy and feel attached to so that they can experience life how they want to. But what if we wanted to find a way to enhance the learning process using certain musical genres? Recently it has become a trend for students to listen to music during study times. The results of this practice show no detrimental effects on the results of the test taken by students, and particularly listening to soft music was found to improve academic performance (Kumar et al., 2016). One's music preference and enjoyment need to be noticed as well. Simply listening to music that you do not prefer can lead to more negative effects. To understand the effects of music on learning processes we need to explore each musical genre and see which one would be ideal. Different genres of music all vary from one another whether by subtle differences or significant distinctions. A systematic review conducted by Velasco and Hirumi (2020) reviewed studies that researched background music and its influence on learning. The results showed that the findings on the topic were mixed, suggesting that more rigorous research should be conducted.

1.2 Music's Cognitive Impact

The interaction between music and the human brain is exciting, given the music's complex structure and the impact it has on our brain (Levitin, 2006). Music lessons are suggested to have positive short-term and a few long-term intellectual benefits, such as verbal

and spatial (Schellenberg, 2005). The effects of music can also be seen in patients with neurological disorders such as Parkinson's disease by improving attention, memory, and executive functions (Sarkamo et al., 2014) When patients engaged in singing and music listening they enhanced their short-term, and working memory along with their quality of life. Music training for children has also been reported to have a positive impact on their listening skills and pattern recognition (Hallam & Price, 1998). Furthermore, certain music types are found to enhance focus and attention. Classical music, for example, has often been looked at closely due to the "Mozart effect" which has been linked to an increase in spatial-temporal reasoning and attention. A study done by Rauscher, Shaw, and Ky (1993) reported that participants who listened to music composed by Mozart, compared to participants who listened to relaxing music or no music at all, had better spatial abilities. Further studies on the same topic found that Mozart's music showed similar positive spatiotemporal effects as the previous study (Jausovec N, Jausovec K, & Gerlic., 2006). However, a comprehensive meta-analysis conducted by Pietschnig, Voracek, and Formann (2010), revealed that the overall effect size was small and that the findings varied significantly. This suggests that while there may be an impact, the evidence indicates it is limited. On top of that, music can also be beneficial psychophysically (Karageorghis & Terry 1997). It can be used as a tool of motivation, to enhance performance during physical activities, and distract us from fatigue and discomfort. However, there is a difference in the type of music when trying to achieve higher physical performance compared to cognitive.

Music is often incorporated by many individuals during their lives in the form of background music. Many students often use background music in combination with learning to enhance their mood, enhance their attention, and reduce their stress. Attention is often found to be modulated by music. In a literature review done by Mendes, Diniz, and Miranda (2021), attention was found to be positively impacted by background music. However, attention was found to vary based on the task at hand and the familiarity with the music which suggests that further research should be conducted to increase the knowledge about the effect. Furthermore, arousal and mood were also found to play a significant role when it came to task performance. Reading comprehension and recall tasks specifically were demonstrated to be affected negatively due to the presence of music or noise (Furnham & Strbac, 2002). In another meta-analysis, the background music was also found to have a small positive effect

size compared to a silent condition when it came to the student's reading skills as part of their overall academic ability (Aksoy 2023). These small effects show that more research should be done to fully understand what effect music has on our brains. The problem is that we cannot classify music as influencing our learning performance, reading capabilities, or cognitive performance. Music is diverse, and to say that fast-paced and aggressive music has the same effect compared to classical and soft music is misleading. Instead of generalizing, we must approach the study of music's influence by considering factors such as genre, tempo, and individual listener preference. Overall, the research on the topic of music sparks the interest of many researchers to delve deeper into the topic and find further information on how and why music influences our actions and cognitive abilities. Since music is so diverse, encompassing a vast range of genres, styles, and cultural influences, researchers are motivated to investigate the specific ways in which these varied elements impact our actions and cognitive abilities and how they interact with our behaviours and psychology. Examining the specific impacts of genres and styles, we can uncover the underlying mechanisms through which music affects not only our social interactions and emotional regulation but also cognitive processes, and even physical health.

1.3 Background Music and Cognitive Performance

Music is often incorporated by many individuals during their lives in the form of background music. Many students often use background music in combination with learning to enhance their mood and reduce their stress. However, lyrics in music may divert the attention of the listener, leading to decreased performance. When it comes to tasks that demand focused attention and concentration, negative effects such as reduced learning efficiency and distractions can occur when the music is fast-paced and loud, even when the music is instrumental (Thompson, Schellenberg, & Letnic, 2012). Music, specifically with lyrics, is found to have greater negative effects such as impaired short-term memory performance compared to instrumental music or silence (Salame & Baddeley, 1989). Instrumental music is preferred over music with lyrics for studying purposes since lyrics are more likely to interfere with verbal tasks such as reading or writing, Use of lyrics in music likely interferes with verbal working memory and causes impaired performance during tasks. When the music is seen as aggressive or arousing it can further hinder memory task performance. Moreover, research done by Hallam, Price, and Katsarou (2002) found that

calming background music enhanced children's performance on comprehension and memory tasks compared to the group with no music condition. Aggressive and unpleasant music disrupted the performance of memory tasks.

The use of fast-paced and upbeat music is also used in physical activities where individuals use it as a distraction and motivator to achieve certain physical goals. This fast-paced music that seems to lift individuals during their physical activities can have reversed effects when used on cognitive abilities. Fast-paced and upbeat music was found to interfere with memory consolidation, particularly in tasks requiring sustained attention (Dalton & Behm, 2007). This leads us to understand that a fast music tempo increases the speed by which we complete a task but also increases the risk of making mistakes within the task. Moreover, a moderate level of music was found to be optimal during tasks that require attention and concentration, but this was all subjective and depended on the listener. In a study conducted by Bottiroli et al. (2014), results were found that indicate how processing speed is improved while listening to upbeat music, and that memory is improved while listening to either downbeat or upbeat music. More detailed results were found in a systematic review conducted by Cheah et al. (2022) stating that many different effects are created by background music, such as that difficult tasks are more negatively impacted by background music than easier tasks, and that music's impact varies depending on the individual's personality traits. Furthermore, different genres of music were found to have different effects on cognitive task performance. Although negative effects of music on memory are found in multiple studies, showing how different music genres and tempos influence our learning and cognitive capabilities negatively, this does not make it clear that music poorly impacts our memory since previous studies also showed how it can improve our memory in certain situations and conditions.

Understanding the impact of background music on cognitive tasks involves examining how personal preferences affect performance. Research has shown that familiar and preferred music can positively influence memory and cognitive processes. A study has shown that personal preferences such as familiar and preferred music tend to have a positive effect on memory tasks compared to unfamiliar or disliked genres (Chew, et.al, 2016). In

another study preferred music with lyrics was found to be as detrimental to reading comprehension as disliked lyrical music (Perham & Currie, 2014). Instrumental music was found to be less detrimental but silent conditions for reading comprehension were found to work best. A study conducted by Schellenberg, and Hallam (2005), found that there are benefits of listening to music during tasks while the listener enjoys the music. The study was conducted on ten-year-olds, and their spatial abilities were increased. Furthermore, Schellenberg, and Weiss (2013) reported that the effects of background music were a consequence of music's capacity to change and improve the mood and arousal level of the listener. These improvements can benefit us in cognitive processing especially if the music that is being listened to is favoured by the listener. Task-focused attentional states were also found to increase when the preferred background music was played (Kiss & Linell, 2021). Individuals often don't care about the type of background music being played when the task at hand is easy, on the other hand when the task becomes harder, people tend to use background music less (Goltz, & Sadakata, 2021). With these findings, we see the importance of the type and characteristics of the background music used in different settings. Individual differences play a role as some individuals prefer music while studying. Others, however, find music distracting and perform better under silent conditions.

1.4 Present Study

The impact of music on our memory has been a topic of considerable interest in educational psychology. Understanding how different music genres influence learning outcomes, particularly in tasks involving reading comprehension, can provide valuable insights into optimizing educational environments. Although music is sometimes seen as having negative effects on the learning process, multiple studies demonstrated that it can positively influence our cognitive performance. This depended on multiple factors such as the type of music, the task used in the study, and the preferences of the participants. Our study tries to add more results to the already existing information about the influence of music on learning processes by exploring how different music such as metal and classical or instrumental and vocal influences our cognitive performance. The research aims to clarify which music benefits cognitive performance when it might be detrimental, and to see if the enjoyment of music can be connected with improved learning capabilities.

2. Aim and Hypothesis

Research Aim 1: This study aimed to investigate the effects of different types of music genres on cognitive performance during learning and recall tasks.

Research Aim 2: This study aimed to investigate whether there is a correlation between participants' enjoyment rating of the music and their test scores.

Hypothesis 1: Participants exposed to instrumental music will perform significantly better on the test compared to those exposed to vocal music. Moreover, participants who listened to instrumental metal and vocal metal will score significantly lower compared to participants in the silent condition.

Hypothesis 2: There will be a positive relationship between individuals' enjoyment rating of the music played during study sessions and the scores of the tests they have taken after the study sessions.

3. Methods

3.1 Study Design

The study was a randomized control trial. All participants were students from the Faculty of Humanities and Social Sciences. Any student studying at the faculty was eligible to participate in this study as long as they were above 18 years old. The original planned sample size was 100 participants and the final sample size was 164 participants (157 females, 7 males). The planned sample size was determined through power analysis. This analysis indicated that 100 participants would provide sufficient statistical power to detect effects at a significance level of 0.05. The sample size was also compared to similar studies, making results more meaningful. All experiments were conducted inside the classrooms of the Faculty of Humanities and Social Sciences. Convenience sample methods were used to select participants. Participants were recruited through professors by extending an invitation to the Faculty.

3.2 Measurements

To measure learning processes we constructed a text on the topic of “Illusion of frequency”. The text explains the frequency illusion, also known as the Baader-Meinhof phenomenon, which is a cognitive bias where individuals notice a concept, word, or product more frequently after recently becoming aware of it. It outlines the causes of this illusion, including selective attention and confirmation bias, and provides examples of how it can affect various situations. The topic was chosen to be sufficiently challenging for the participants, ensuring that they would actively engage with the material and decrease the chance of relying on prior knowledge. After the text had been read, participants were given a set of targeted questions based on the provided content. The participants also rated on a scale of 1 to 10 how much they enjoyed the music being played.

3.2.1 Content of the Test

Participants were asked to fill out an open-ended question asking about their age and sex (male, female). The test consisted of 10 questions and focused on both recall of specific facts and understanding of key concepts discussed in the text. The questions ranged from true/false and fill-in-the-blank formats, ensuring a comprehensive assessment of the participant's learning processes. The last question asked the participants to rate how much they enjoyed the music being played on a scale from 1 to 10.

3.3 Procedure

Before the experiment began, each group was informed about the study and asked to sign an informed consent form to confirm their participation in the experiment. This informed consent outlined the purpose of the study, risks and benefits, and the question about confidentiality and data security. Participants had the opportunity to ask further questions before signing the consent form. If participants refused to sign the informed consent or did not wish to be a part of the experiment, they would be free to leave. Each group was exposed to a musical genre that would play during the experiment. This was achieved using a random number generator to ensure that each group had an equal chance of being exposed to any of the music conditions. These musical genres were instrumental classical, vocal classical, instrumental metal, vocal metal, or no music at all. The specific music pieces that were played for each group can be seen in *Table 1*. Most pieces of music were deliberately chosen to have a slow or moderate tempo and were in a minor key (mostly D minor). The intervention was delivered by the researcher, who is a student conducting this study as part of their final thesis. The researcher was responsible for setting up and playing the selected musical pieces, distributing the reading materials, and administrating the tests to the participants. Once the experiment began, the participants were given a text on the topic of “Illusion of frequency” which they were instructed to study. Participants were instructed to read the text for 10 minutes after which the reading material was collected and they were handed out a test on the same topic that they would have to complete. In between the reading phase and the writing phase, a 2-minute break was administered. After the break, the participants had 5 minutes to answer the questions on the test to the best of their abilities. To precisely track time a stopwatch was used. Music was being played through a speaker, loud

enough so that everyone in the classroom could hear it, and positioned at the front of the classroom facing towards the participants.

Table 1

Musical pieces played for each condition

Musical Condition	Pieces Played
Instrumental Classical	-Mozart's "Piano Concerto #20 in D minor, Romanze" -Beethoven's "String Quartet No.15 in D Minor, Allegro"
Instrumental Metal	-"Black Sabbath" by Black Sabbath -"Fear Not" by Soliloquium
Vocal Classical	-Mozart's "Lacrimosa" -Carl Orff's "O Fortuna" -"When I am Laid in Earth" from Purcell's Dido and Aeneas
Vocal Metal	-"Solitude" by Candlemass -"The Black Mass" by Pagan Altar -"Soviet Invasion" by Witchfinder General
No Music	-No music was played

3.4 Pilot Study

Before the final version of the experiment was conducted, multiple pilot studies were performed to detect difficulties and complications in the experiment. There was a total number of 3 completed pilot studies before the experiment, with the first pilot study containing 8 participants, the second 10, and the last containing 10 participants as well. Testing was completed in a similar environment as the experiment and helped improve and ensure the effectiveness of the research and remove remaining issues. The participants were all students, although not from the Faculty of Humanities and Social Sciences and they were of approximately the same age (19-25). Participants for the study were recruited through personal networks and the recruitment was facilitated through informal invitations, which made participation more accessible. Participants were also asked to provide feedback based on their experience. Through this process, we adjusted the position of the speaker and adjusted the volume to ensure consistent music conditions for all participants. We also shortened the text to reduce the number of information that needed to be studied as well as increased the time to write the test from 3 minutes to 5 minutes.

3.5 Ethical Considerations

The research has been approved by the Ethics Committee of the Faculty of Humanities and Social Sciences in Split (Ethical committee approval number: 2181-190-24-00014). The results of the experiment cannot be traced to the identity of the participants since the informal consent was not attached to the results of the research. All data was stored securely, and only the mentor and the researcher had access to the data. Participation was entirely voluntary, with no pressure or coercion. After the study, participants were provided full debriefing, where they were informed about the full nature of the study, including its aims and any potential impacts of the research.

3.6 Data Analysis

Data analysis was performed using RStudio software (RStudio Team, 2024**)** and descriptive statistics were assessed using the "psych" package (Revelle, 2023). Shapiro-Wilk normality test was used to evaluate the normality of the distribution. Spearman's rank correlation was used to examine the association between enjoyment of music and test scores. Finally, a Kruskal-Wallis H test followed by a Conover-Iman post-hoc test, was used to determine if there were significant differences between groups and to identify which specific groups significantly differed ($p<0.05$). A box plot and multiple tables were used to help interpret the data.

4. Results

The purpose of the research was to determine whether there are significant differences in test scores across different musical conditions. To test this, we used a Kruskal-Wallis test. The sample consisted of 164 participants, 7 of them being male and 157 female. The median age was 21 (IQR: 19-22) with a total range from 19 to 27. The smallest mean number of correct answers came from the vocal metal group while the silent condition group had the biggest average of correct answers (*Table 2*). This indicates that participants who listened to vocal metal music during the task performed the worst, on average, in terms of correct answers on the test. By contrast, participants in the silent condition, who were not exposed to any music or noise, performed the best on average.

Table 2

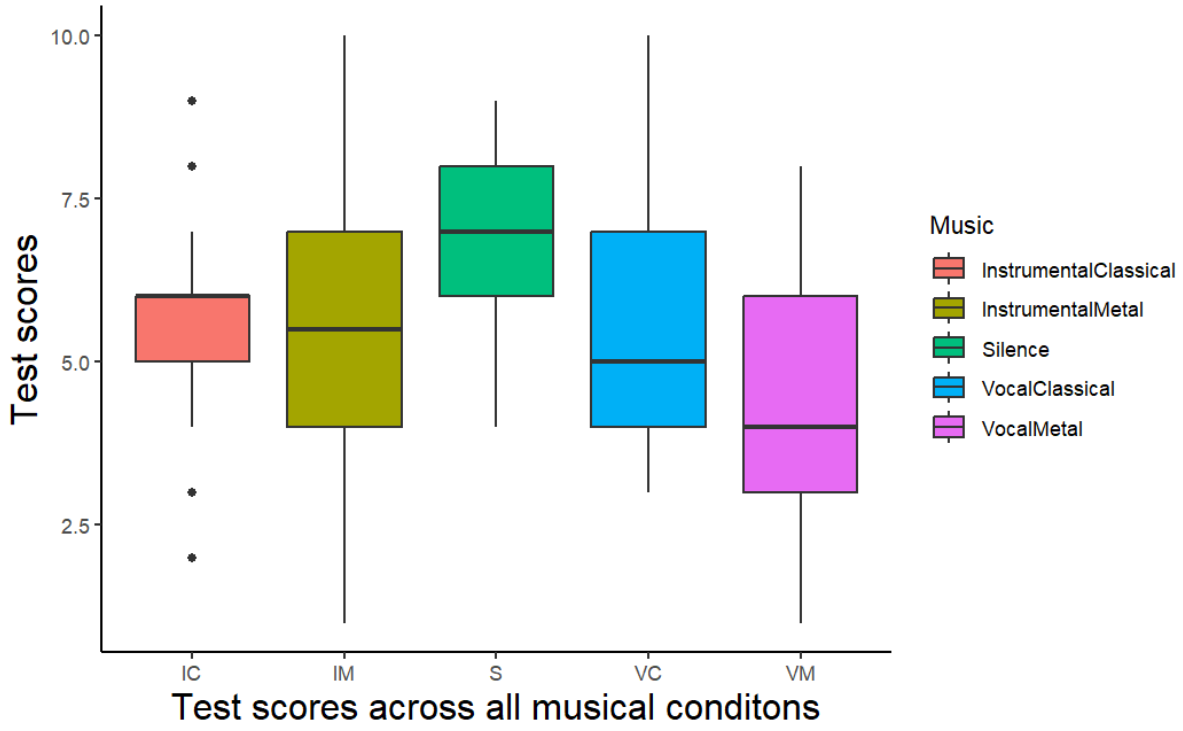
Descriptive statistics for each musical condition

		Test Scores			
			CI 95%		
Musical Condition	N	Median	Lower	Upper	Skewness
Instrumental classical	33	6	2.8	9	0.28
Instrumental metal	34	5.5	1	9.175	-0.11
Vocal Classical	33	5	3	10	0.45
Vocal metal	35	4	1	8	0.18
Silence	29	7	4	9	-0.46

Shapiro-Wilk normality tests were conducted to assess the normality of the distribution of the test scores within each group. The results indicated that the scores in Instrumental Classical (W=0.951, p=0.1418), Instrumental Metal (W=0.975, p=0.624), groups were not significantly different from a normal distribution, but Vocal Classical (W=0.917, p=0.015), Vocal Metal (W=0.923, p=0.017), and Silent condition (W=0.906, p=0.013) were found to significantly differ from a normal distribution. Finally, we conducted a Kruskal-Wallis test to determine if there were significant differences between the groups. The analysis showed a significant difference between the groups, (H=24.361, p<0.001). *Figure 1* shows the differences between the groups based on test scores.

Figure 1

Boxplot of test scores across different musical conditions



Following the results of Kruskal-Wallis, a Conover-Iman post-hoc analysis was used to determine which groups showed significant differences. The test revealed that there is a highly significant difference between vocal metal and silence ($p<0.001$), instrumental metal and silence ($p<0.0013$), vocal classical and silence ($p<0.0028$), vocal classical and vocal metal ($p<0.0066$), instrumental and vocal metal ($p<0.0054$), instrumental classical and silence ($p<0.0034$). There was also a significant difference between instrumental metal and vocal metal ($p<0.012$). No other comparisons were found to have significant differences (*Table 3).*

Table 3

Post-hoc analysis of test score differences by musical condition.

	Test Scores	
Comparison	**Mean diff**	**P-value**
Instrumental classical vs. instrumental metal	0.31	0.377
Instrumental classical vs. vocal classical	0.07	0.472
Instrumental classical vs. vocal metal	2.58	0.005**
Instrumental classical vs. silence	-2.75	0.003**
Vocal classical vs. vocal metal	2.51	0.006**
Vocal classical vs. instrumental metal	0.24	0.405
Vocal classical vs. silence	-2.81	0.002**
Instrumental metal vs. silence	-3.07	0.0013**
Instrumental metal vs. vocal metal	2.28	0.012*
Vocal metal vs. silence	-5.28	0.001***

*p<.05, **p<.01, ***p<.001

Finally, Spearman's rank-order correlation was used to examine the relationship between the participant's enjoyment ranking of the music being played and the test scores. The data revealed a weak positive correlation between them ($r(132) = 0.208$, $p = 0.016$) The positive relationship between how much participants rated their enjoyment of the music being played and their test scores is statistically significant but the correlation is small with the 95% confidence interval for the correlation coefficient ranging from 0.040 to 0.365.

5. Discussion

The current study explored the impact of different musical genres on learning outcomes among students. The results of the study create insights into the influence of music genres and our enjoyment and preference of music on our cognitive performance. The findings indicate that the silent condition is the optimal condition for learning processes, while vocal musical, specifically metal vocal music was found to severely negatively impact participants' learning processes. There is no evidence in the study that supports the idea of music positively impacting learning processes. Moreover, the enjoyment rating of the music played was found to have a small positive relationship with scores on the test. These findings support multiple hypotheses and provide a further understanding of a topic that has shown mixed results.

Firstly, participants who listened to vocal metal and vocal classical music compared to those in silent conditions were found to have significantly lower test scores. This result shows that music containing lyrics could be a distracting factor during tasks involving learning processes, making them perform significantly worse. These results are supported by multiple studies that indicate how lyrics can cause distractions and reduce cognitive performance (Salame & Baddeley, 1989; Thompson, Schellenberg, & Letnic, 2012; Goltz & Sadakata, 2021). Interestingly enough, the vocal classical group scored significantly higher compared to the vocal metal group. This suggests that while music with lyrics can be a distracting factor, using music such as metal music that is already complex, loud, and aggressive can further reduce cognitive abilities (Patston & Tippett, 2011). This difference in test scores further suggests that the presence of harsh or complex music with vocals may hinder cognitive processing and recall more than instrumental music or softer vocal music like classical.

Instrumental music, regardless of whether it was played in its classical or metal form, significantly differed in its influence on test scores compared to the silent condition. This would mean that the results of our experiment support our initial hypothesis. The hypothesis stated that both vocal and instrumental metal groups would score significantly lower compared to the silent condition. On average participants in the silent condition were shown

to score significantly more points on the test compared to any other group. Some studies have concluded that instrumental music does not disrupt reading comprehension significantly, compared to the silent condition (Perham & Currie, 2014), while others have reported negative effects on instrumental music (Thompson, Schellenberg, & Letnic, 2012). Our research supports the findings of previous research that found instrumental music to be significantly disruptive compared to the silent condition. Unfortunately, we have not found any significant evidence of positive effects on cognitive ability due to the presence of instrumental music. Instrumental classical was also found to negatively impact our learning processes compared to the silent condition. There was no difference between instrumental metal, instrumental classical, and vocal classical, further suggesting that vocal metal disrupts our cognitive performance due to harsh vocals.

The similar performance between instrumental classical and instrumental metal groups suggests that the impact of music may be more related to its instrumental nature rather than the specific genre. This can be due to the sheer reason of not having lyrics. Although metal music is found to be more complex, without lyrics it plays a similar role compared to classical music. The difference can be in the tempo since we played more slow to medium-tempo metal songs. Using fast-tempo metal songs could prove to disrupt cognitive performance even to the level of vocal metal music.

Participants in the silent condition achieved the highest test scores. Previous studies on the topic found that the results were mixed. In some studies attention and cognitive abilities were found to be improved during tasks with calming music (Hallam, Price, & Katsarou, 2002), other studies showed that there was no effect or that there was a detrimental effect on cognitive task performance (Furnham & Strbac, 2002; Dalton & Behm, 2007). This finding supports previous studies indicating that silence or minimal distraction often provides the most effective environment for focus and recall (Salame & Baddeley, 1989; Schellenberg & Hallam, 2005). The significant difference between the silent condition and all musical conditions underscores the extent to which music can be a distracting factor and impede learning, while the absence of such distractions appears to optimize cognitive function.

The study also explored the correlation between ratings of enjoyment of music and test scores, revealing a weak but statistically significant positive correlation. This indicates that while enjoyment of music has some impact on test performance, it is not the primary determinant. Some studies indicate that even preference for music as background music can play a role in improving cognitive memory, specifically with positive effects for those that are used to background music and negative effects for those that are not (Su, & Wang, 2010). The small effect size suggests that other factors, such as the tempo, music's content, and structure play a more critical role in influencing academic outcomes. This finding is in line with studies suggesting that while a preference for music can enhance the subjective experience, its impact on cognitive performance is limited and highly context-specific (Chew, et.al, 2016; Schellenberg & Hallam 2005). Preference and enjoyment of music as previously stated can have an impact on our cognitive abilities, but even preferred music with lyrics was found to have detrimental effects (Perham & Currie, 2014). This leads us to believe that enjoyment might not play as a big role as we think it does.

While the study provides valuable insights, several limitations should be acknowledged. Firstly, the study's sample was heavily skewed towards female participants. Future research could benefit from a more balanced sample, as well as exploring a wider range of musical genres and more diverse participant demographics. The sample size can also be increased depending on the number of groups in the experiment. Another limitation lies in the duration of exposure to music. The 10-minute listening period may not fully capture the long-term effects of music on cognitive performance. Longer-term studies provide more comprehensive insights into how sustained exposure to different types of music impacts cognitive performance over time. The tempo of the music varied to an extent. This could have influenced the results since although most music was in slow to moderate tempo, some of them were fast tempo. Although all the music play played in the minor key they were not played in the same specific key, such as D minor or G minor. Finally, we used a speaker as a way of conveying music to the participants. The speaker was positioned to ensure that all participants could hear the music. However, this setup may present challenges, mainly in larger groups as participants closer to the speaker may experience different sound quality compared to those farther away. Future studies could address this issue by using multiple speakers or providing participants with headphones. Ideally, testing participants individually could further improve the consistency of the experiment. Future studies should also

implement different genres of music when it comes to instrumental music, seeing how classical music displayed no disruption in cognitive abilities compared to metal music.

6. Conclusion

This study contributes to our understanding of how different types of music influence learning and cognitive performance. The findings show that all types of music may impair individuals learning performance. Silence while studying is found to be better at getting higher test results compared to all other music types. Additionally, the positive correlation between music enjoyment indicates that individual preferences should be considered when assessing the impact of music on cognitive tasks. Further research is needed to explore these relationships in more depth and across different contexts.

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7. Abstract

This study investigated how background music impacts our cognitive abilities, specifically examining how different music genres affect test scores among students. With a sample size of 164 participants, the research used a randomized control trial where students were exposed to one of four music conditions (instrumental classical, vocal classical, instrumental metal, vocal metal) or silence while studying a text on the topic of “Illusion of Frequency”. Participants were allocated to these conditions using convenience sampling. Kruskal Wallis along with descriptive statistics was used in the R studio software to analyze the differences between the groups. Results showed significant differences in test scores across several musical conditions. Participants in the silent condition scored highest, while participants exposed to vocal metal music scored significantly lower, suggesting that complex and vocal music may hinder cognitive performance. Every other musical condition was shown to significantly disrupt learning processes compared to the silent condition. Furthermore, there was a weak but significant positive correlation between music enjoyment and test scores, indicating that while music enjoyment influences cognitive performance, it is not the primary factor. The study's results highlight the potential cognitive benefits of silence or instrumental music during study sessions, while also acknowledging limitations such as the female-majority sample and the short duration of music exposure. The findings contribute to the ongoing debate on whether music impacts learning and suggests open areas for future research to explore and find the interplay between music, enjoyment, and cognitive performance.

Sažetak

Ovo istraživanje istraživalo je kako glazba u pozadini utječe na naše kognitivne naše sposobnosti, specifično ispitujući kako različiti glazbeni žanrovi utječu na rezultate testova među studentima. S veličinom uzorka od 164 sudionika, istraživanje je koristila randomizirano kontrolirano istraživanje gdje su studenti bili izloženi jednom od četiri glazbena uvjeta (instrumentalna klasika, vokalna klasika, instrumentalni metal vokalni metal) ili tišini dok su proučavali tekst na temu "Iluzija frekvencije". Studenti su raspoređeni u ove uvjete korištenjem pogodnog uzorka. Kruskal-Wallis skupa sa deskriptivnom statistikom je korištena u Rstudio softveru na analizu razlika između skupina. Rezultati su pokazali značajne razlike u rezultatima testova u nekoliko glazbenih uvjeta. Sudionici u tihom okruženju su postigli najviše bodova, dok su sudionici koji su bili izloženi vokalnoj metal glazbi postigli značajno niže rezultate, što sugerira da složena i vokalna glazba može ometati kognitivne sposobnosti. Pokazalo se da svaki drugi glazbeni žanr ometa proces učenja u usporedbi s tihim stanjem. Postojala je i slaba, ali značajna pozitivna korelacija između užitka u glazbi i rezultata na testu, što ukazuje da uživanje u glazbi, iako utječe na kognitivne sposobnosti, nije primarni faktor. Rezultati eksperimenta naglašavaju potencijalne kognitivne prednosti tišine ili instrumentalne glazbe tijekom vremena učenja, dok također priznaju ograničenja kao što su nenasumični uzorak i kratko trajanje izlaganja glazbe. Rezultati pridonose raspravi koja je u tijeku o tome utječe li glazba na učenje i predlažu otvorena područja za buduća istraživanja i pronalaženje međuigre između užitka i kognitivnih sposobnosti.

8. Supplement

Table 4

CONSORT Checklist

Section/Topic	Item No	Checklist Item	Reported on page No**
Title and abstract			
	1a	Identification as a randomized trial in the title	24
	1b	Structured summary of trial design, methods, results, and conclusion	N/A
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	1
	2b	Specific objectives or hypotheses	6
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	7
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants	4a	Eligibility criteria for participants	7
	4b	Settings and locations where the data were collected	7
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	8
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	N/A
	6b	Any changes to trial outcomes after the trial commenced, with reasons	N/A
Sample size	7a	How sample size was determined	7
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomization:	8a	Method used to generate the random allocation sequence	8
Sequence generation	8b	Type of randomization; details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers),	N/A
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	N/A
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	N/A
	11b	If relevant, a description of the similarity of interventions	N/A

Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	11
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	N/A
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	12
	13b	For each group, losses and exclusions after randomisation, together with reasons	N/A
Recruitment	14a	Dates defining the periods of recruitment and follow-up	N/A
	14b	Why the trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	N/A
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	N/A
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	12
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms	19	All important harms or unintended effects in each group	N/A
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	18
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	N/A
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	16
Other information			
Registration	23	Registration number and name of trial registry	N/A
Protocol	24	Where the full trial protocol can be accessed, if available	N/A
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	N/A

Appendix A
Text on the topic of frequency of illusion

Iluzija frekvencije (također poznata kao Baader-Meinhofov fenomen) kognitivna je pristranost u kojoj osoba češće primjećuje određeni koncept, riječ ili proizvod nakon što je nedavno postala svjesna njih.

Naziv „Baader-Meinhofov fenomen“ osmislio je 1994. Terry Mullen u pismu St. Paul Pioneer Press. U pismu se opisuje kako je, nakon što je jednom čuo ime njemačke terorističke skupine Baader-Meinhof, stalno to primjećivao. To je dovelo do toga da su drugi čitatelji podijelili svoja vlastita iskustva o tom fenomenu, što je dovelo do njegovog prepoznavanja. Tek 2005. godine, kada je profesor lingvistike na Stanfordu Arnold Zwicky pisao o ovom učinku na svom blogu, formuliran je naziv „frekvencijska iluzija“.

Nekoliko je mogućih uzroka iluzije frekvencije, vremenom je uvriježen stav da su glavni uzroci kognitivne predrasude i učinci povezani s pažnjom koji su sa iluzijom u interakciji.

Zwicky je ovu iluziju smatrao rezultatom dva psihološka procesa:

- selektivne pažnje i pristranosti potvrde.

Pa možemo zaključiti da je glavni uzrok iluzije frekvencije i drugih srodnih iluzija i predrasuda, selektivna pažnja.

Selektivna pažnja odnosi se na proces odabira i fokusiranja na selektivne objekte uz ignoriranje distrakcija.

To znači da ljudi imaju nesvjesnu sposobnost filtriranja za ono na što su usredotočeni.

Selektivna pažnja uvijek je u igri kad god se pojavi frekvencijska iluzija. Budući da se selektivna pažnja usmjerava na informacije koje traže, njihovo će iskustvo frekvencijske iluzije također biti usmjereno na iste podražaje. Proces frekventne iluzije neodvojiv je od selektivne pažnje, zbog uzročno-posljedične veze između to dvoje, tako da „česti“ predmet, fraza ili ideja moraju biti selektivni.

To znači da bi nečiju pozornost mogao privući samo posebno poticajan ili emotivan podražaj, više od običnog zadatka.

Pristranost potvrde je kognitivna pristranost koja je uvijek u interakciji s frekvencijskom iluzijom. Ova pristranost se odnosi na tendenciju traženja dokaza koji potvrđuju nečija uvjerenja ili hipoteze, dok se ponekad zanemaruju dokazi koji govore suprotno.
Pristranost potvrde stupa na snagu u kasnijim fazama selektivne pažnje, kada je pojedinac već počeo primjećivat određeni podražaj. Usredotočujući se na ovaj specifičan podražaj, pojedinac ga sve više primjećuje, čime se potvrđuju njihove sumnje da se pojavljuje češće, iako se u stvarnosti učestalost nije promijenila. U osnovi, pristranost potvrde javlja se kada

pojedinac pod utjecajem iluzije frekvencije počne tražiti uvjeravanje u ovu povećanu učestalost, vjerujući da su njegove teorije potvrđene sve iz razloga jer se usredotočuje samo na dokaze koji ih podupiru.

Recentna iluzija je još jedan selektivni učinak pažnje koji teži pratiti iluziju frekvencije. Ova se iluzija javlja kada pojedinac nešto primijeti nedavno, što ga navodi da bude uvjeren da je i to nedavno nastalo. Ovaj fenomen pojačava iluziju frekvencije budući da navodi osobu da postane svjesnija nedavnih podražaja i povećava šanse da se usredotoči na nju u bliskoj budućnosti.

Slično iluziji učestalosti-frekvencije, recentna iluzija također je rezultat selektivne pažnje i može se nadvladati provjerom činjenica.

Za većinu ljudi iluzija frekvencije neće dovesti do većih učinaka. To je jednostavno zanimljiva pojava. Ali za druge, iluzija frekvencije može dovesti do ozbiljnih ishoda.
Na primjer, ako radite u području kriminologije, vaša pozornost može biti usmjerena na određenog osumnjičenika. Vaš će um tada biti skloniji obratiti pozornost na tu osobu kada se pojave nove informacije. To bi moglo pomoći slučaju i odvesti detektiva do pravog osumnjičenika- Ali može biti i štetno. Ako je detektivov um usredotočen na jednu osobu, mogli bi propustiti druge ključne dokaze.

U drugim slučajevima, ako imate određene psihološke poremećaje, frekvencijska iluzija može pogoršati vaše stanje. Ako imate shizofreniju, potvrdna pristranost zbog iluzije frekvencije može uzrokovati da potvrdite vlastite sumnje. Ako se usredotočite na određenu zabludu koju imate od shizofrenije, iluzija frekvencije može vas uvjeriti da je nešto stvarno iako nije.

Slijedom navedenog možemo dati širu definiciju frekvencijske iluzije.
Frekvencijska iluzija (također poznata kao Baader-Meinhofov fenomen) predstavlja kognitivnu pristranost u kojoj osoba češće primjećuje određeni koncept, riječ ili proizvod nakon što je nedavno postala svjesna njih. Ona pri tom, selektivnom pažnjom, koristeći nesvjesnu sposobnost filtriranja za ono na što je usredotočena često traži potvrdu preko povećane učestalosti.

Appendix B
Test on the topic of frequency of illusion

1. Tko je osmislio termin „Baader-Meinhof fenomen“ i u kojoj godini?
   _____
   ___
2. Iluzija frekvencije kognitivna je pristranost u kojoj osoba češće primjećuje određeni koncept, riječ ili proizvod nakon što je nedavno postala svijesna njih.
   DA/NE
3. Navedi dva glavna psihološka procesa koja su povezana uz frekvenciju iluzije
   _____ _____
4. Tko je dao naziv „Frekvencijska iluzija“? _____
5. _____ odnosi se na proces odabira i fokusiranja na objekte uz ignoriranje distrakcija.
6. _____pojačava iluziju frekvencije budući da navodi osobu da postane svjesnija nedavnih podražaja i povećava šanse da se usredotoči na nju u bliskoj budućnosti.
7. Pristranost potvrde stupa na snagu u ranijim fazama selektivne pažnje, kada je pojedinac već počeo primjećivati određeni podražaj.
   DA/NE
8. Pristranost potvrde se odnosi na tendenciju traženja dokaza koji potvrđuju nečija uvjerenja ili hipoteze, dok se ponekad zanemaruju dokazi koji govore suprotno.
   DA/NE
9. Slično iluziji učestalosti-frekvencije, recentna iluzija također je rezultat _____ i može se nadvladati provjerom činjenica.
10. Od 1 do 10 koliko vam je se svidjela glazba (1= niti malo, 10= super je) _____

Izjava o pohrani i objavi ocjenskog rada
(završnog/diplomskog/specijalističkog/doktorskog rada - podcrtajte odgovarajuće)

Student/ica: Dani Mažić

Naslov rada: Influence of different music genres on learning process: randomized control trial

Znanstveno područje i polje: Društvene znanosti: Psihologija

Vrsta rada: Završni rad

Mentor/ica rada (ime i prezime, akad. stupanj i zvanje):
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Napomena:

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Obrazac A.Č.

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