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Music and Memory Efficiency: The Impact of Existence or Absence of Lyrics on Verbal Memory Performance

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Abstract: A large body of assessments have been conducted to demonstrate the impact of music on cognitive abilities, yet few of them are about how the existence or absence of lyrics can have influence on verbal memory performance. This study consists of a between-groups behavioural experiment which tested 30 high school students between ages of 16 to 18. Three groups of participants were asked to recall a list of words when exposed to environments of music without lyrics, music with lyrics, and no music. The paper hypothesized that the presentation of music with lyrics will reduce verbal memory performance compared to music without lyrics. An ANOVA statistic analysis indicated that the results for the experiment were non-significant.

Keywords: music, lyrics, short-term memory, verbal memory.

1. Introduction

As one of the general languages of human beings, music not only spreads out information with its lyrics, but also generates influences to our cognitive regulations. Many studies have been done in the similar field. Researchers have proven that a music-exposure environment improves learning and memory capability of mice [8]. By measuring brain activities in the cortex and hippocampus of different groups of mice, a significant increase of gene regulation has been detected in music-exposed ones. Later, neuroscientists demonstrated that music cognition can be preserved in advanced dementia, proving that the human brian generates music information in a different brain area that cannot be affected by Alzheimer's disease [7]. Meanwhile, another study provides evidence of gender difference in recall efficiency when music as an external stimulus [10]. According to the result, female participants performed better than males in the recall process, despite music genres. The previous studies aimed at proving a certain relationship between music and neuroscience, from differences between non-human animals and humans to gender differences.

Indeed, music influences multiple aspects of daily lives, which is the reason I found it intriguing to investigate the effect of music having lyrics or not on human verbal performance. Yet journals about the influence of music with or without lyrics on verbal memory are not many within databases, and the knowledge gap is self-evident–not a substantial amount of research done on the effect of music with and without lyrics on verbal memory performance. According to previous research, the human brain holds limited capacity [9] and limited duration [2] for encoding information. In this case, generating information from music with lyrics may occupy more cognitive capacity, which reduces verbal memory performance quality.

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To investigate this hypothesis, Howard Li and I have designed a behavioural experiment that can strengthen the evidence that former researchers provided. The present study aimed at examining whether the presentation of music with lyrics will reduce verbal memory performance compared to music without lyrics, adding a novel direction of future research on the relationship between music and human cognition. Meanwhile, questions are also raised from our research results, that allow the follow-up studies to discuss.

2. Methods

The present study contains a behavioural experiment with quantitative results examining the quality of short-term verbal memory performance, which in this case, the efficiency of recalling assigned words. The final goal of this experiment is to investigate the impact of existence or absence of music lyrics on a subject's short-term memory. The independent variables were three different conditions with whether music lyrics existed or not, and the absence of music as the control group. A total of 30 (N = 30) healthy individuals between the ages of 16 and 18 were randomly recruited from Shanghai Qibao Dwight High School to participate in this study. All of them are Chinese high school students that can understand English, despite the gender ratio. The different levels of education were also not included in this study because the sample selection has been made. This study was performed in the format of one to one online meeting. The instructions were presented both orally and on the powerpoint in English.

Each subject was told to complete a verbal memory task under three conditions: 1) no music (N = 10), 2) with music that had lyrics (N = 10), 3) with music that did not have lyrics (N = 10). The music (if any) was started to play once the participant joined the meeting. The music that was used was Levitating by Dua Lipa. The music genre differences were not included in this study. Participants were each shown a timed powerpoint slide deck that included thirteen words. Each presented one at a time for 3 seconds. All of the words were neutral, commonly used words randomly selected from a curated wordlist (Toglia & Battig, 1978). Words were drawn from clusters of six and seven of the word norms and were all 4-8 letter nouns that were rated as highly familiar (range 5.5-7 on a 1-7 scale), moderate to high on concreteness and imagery (range 4.5-6 on a 1-7 scale), and moderate in pleasantness (range 2.5-5.5 on a 1-7 scale). The encoding block took a total of thirty-nine seconds. After encoding, a 30-second non-mnemonic distraction task was completed. The distraction task consisted of a math question: "7 x 8 + 27 = ?" . After the distraction block, a recognition memory test block was completed, during which, participants were shown a list of thirty words (thirteen old and seventeen new). The new words were also chosen from the same wordlist using the same parameters for selection. For each condition, participants were asked to recognize words that they have seen in the previous session and circle as many as possible. This block took one minute.

The dependent variable was the quality of participants' verbal memory performance, which was measured by the number of word subjects recalled correctly. The number of words subjects recalled in total was also calculated. The number of words subjects recalled incorrectly was not considered in statistical analysis. The statistical analysis of the data was performed by using the Statistical Package for the Social Sciences (SPSS), version 27.0 (IBM). The homogeneity of variance was evaluated by using Levene's Test of Equality of Error Variance. All quantitative variables were expressed by mean value (M) and standard deviation (SD). A one-way between-groups analysis of variance (ANOVA) was performed, with music conditions (with lyrics/without lyrics/no music) as independent variables, and the number of words that were correctly recalled as the dependent variable. All tests were one-tailed, and statistical significance was considered for p-values less than 0.05.

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3. Results

The diagnostic test that was drawn between music conditions (with lyrics/without lyrics/no music) and the number of words subjects recalled correctly demonstrated that the assumption of homogeneity of variance had been met between the groups (Levene's Test, $p > .05$). The Levene's Test of Equality of Error Variances is presented in Figure 1. A one-way between-groups ANOVA revealed a large-sized significant main effect on the influence of different music conditions on subjects' verbal memory performance, F (2,27) = 4.00, $p = .030$, $\eta_p^2 = .229$. The main effect statistics are shown in Figure 2. Post hoc comparisons using Tukey's *HSD* test indicated that no significant differences were found among the group with lyrics (M = 8.40, SD = .70), the group without lyrics (M = 9.20, SD = .63), and the group without music (M = 8.40, SD = .84), with $p = .03$. The comparison of Tukey's *HSD* test and Bonferroni procedure are listed in Figure 3. The mean value and standard deviation of three groups are presented in Figure 4.

Levene's Test of Equality of Error Variances[a,b]

		Levene Statistic	df1	df2	Sig.
Correct attempt	Based on Mean	.707	2	27	.502
	Based on Median	.468	2	27	.632
	Based on Median and with adjusted df	.468	2	20.579	.633
	Based on trimmed mean	.633	2	27	.539

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: Correct attempt

b. Design: Intercept + Condition

Figure 1: Levene's Test Analysis.

Note: the p-value displayed at the intersection of the row labeled "Based on Mean"and the column labeled "Sig.".

Tests of Between-Subjects Effects

Dependent Variable: Correct attempt

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4.267[a]	2	2.133	4.000	.030	.229
Intercept	2253.333	1	2253.333	4225.000	.000	.994
Condition	4.267	2	2.133	4.000	.030	.229
Error	14.400	27	.533			
Total	2272.000	30				
Corrected Total	18.667	29				

a. R Squared = .229 (Adjusted R Squared = .171)

Figure 2: Tests of Between-Subjects Effects.

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Note: the column labeled "F" provides the F statistics, the column labeled "Sig." lists the p-values, and the column labeled "Partial Eta Squared" provides the effect size estimates.

Multiple Comparisons

Dependent Variable: Correct attempt

	(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	With lyrics	Without lyrics	-.80	.327	.053	-1.61	.01
		No music	.00	.327	1.000	-.81	.81
	Without lyrics	With lyrics	.80	.327	.053	-.01	1.61
		No music	.80	.327	.053	-.01	1.61
	No music	With lyrics	.00	.327	1.000	-.81	.81
		Without lyrics	-.80	.327	.053	-1.61	.01
Bonferroni	With lyrics	Without lyrics	-.80	.327	.063	-1.63	.03
		No music	.00	.327	1.000	-.83	.83
	Without lyrics	With lyrics	.80	.327	.063	-.03	1.63
		No music	.80	.327	.063	-.03	1.63
	No music	With lyrics	.00	.327	1.000	-.83	.83
		Without lyrics	-.80	.327	.063	-1.63	.03

Based on observed means.
The error term is Mean Square(Error) = .533.

Figure 3: Post Hoc Tests.

Note: the results of the comparisons using the Bonferroni procedure are consistent with those of Tucky's *HSD* test.

Between-Subjects Factors

		Value Label	N
Condition	1	With lyrics	10
	2	Without lyrics	10
	3	No music	10

Descriptive Statistics

Dependent Variable: Correct attempt

Condition	Mean	Std. Deviation	N
With lyrics	8.40	.699	10
Without lyrics	9.20	.632	10
No music	8.40	.843	10
Total	8.67	.802	30

Figure 4: Descriptive Statistics.

Note: the numbers are derived by using SPSS.

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4. Conclusions

Overall, the results of the present study support previous studies that music has an effect on short-term memory, yet no statistically significant differences were found between different groups in the experiment. In other words, the null hypothesis that the existence of music lyrics has no influence on the subject's quality of verbal memory performance cannot be rejected. Although ages and the total number of words that the subject recalled were also calculated in data, neither of them shows significant influence on the general performance of short-term verbal memory. Yet in this situation, the misrecognition of words was not considered as one of the variables that may influence the general result of the study.

It is also worth noting that the finding of the present study is disassociated with some previous studies in which participants performed differently under different conditions. Studies that have been done on background music and cognitive performance provide evidence that different music genres can affect subjects' cognitive abilities. According to Bugter and Carden's study, which is the similar one-way between-groups experiment as the present one, participants in the group that was exposed to classical music performed significantly better on a cognitive Concentration game than those in the group that was exposed to rap music [3], with no other significant difference been found. Meanwhile, the Angel et al. paper suggests that background music significantly increases the quality of both verbal and non-verbal performance, by using a linguistic processing task and a spatial processing task [1]. It turns out that participants exposed to Mozart's music completed both linguistic and spatial processing tasks faster. Yet for both studies, participants completing tasks in a silent environment showed no increases or decreases in efficiency, which corresponds with findings of the present study, and the Harmon et al. paper [6]. The paper compared the efficiency of participants completing cognitive tasks in environments exposed to Mozart's music and rock music. Further statistical analysis indicated that the results for both conditions were non-significant.

Limitations and Future Directions: The present study aimed at demonstrating any potential impact that music with or without lyrics can have on verbal memory performance, while neglecting music genre and gender differences. This study only investigated disco music in this situation. Yet looking through the broader view of related studies, classical music such as Mozart's excerpts are widely used. Indeed, it is difficult for researchers to regulate all of the music tempo into a single experiment, not to mention that the measurement of music genre can be ambiguous. Multiple studies and adjustments are necessary. The previous findings on rock music and classical music are dissociated, indicating that music tempo needs to be adjusted wisely. Meanwhile, the power of familiarity on memory was not considered in the present study. The participants' previous familiarity of the music used in this experiment was not tested, which has the potential to induce a third-variable problem. According to Thomson and Tulving's encoding specificity principle, it is possible for the participants to retrieve memories under the context that is similar to the encoding context (Thomson & Tulving, 1973). The increase of familiarity may also promote the confidence of the retrieval of a certain list of items.

Similar considerations need to be adjusted discreetly for participants as well. Based on previous research, sleep deprivation would influence working memory performance, whereas some substances such as caffeine may have a positive impact on hormones (Gerhardsson et al., 2019; Fiani et al., 2021). A positive correlation of hormone regulation and cognitive activity was found in the experiment of mice and music-exposed environment. In this study, neither of them was regulated intentionally, not to mention that the sample size was limited, which may reduce the external validity of the results.

Furthermore, the present study did not take gender difference into account. As the findings mentioned before, researchers have shown that the cognitive abilities are significantly different between males and females. Guillem and Mograss have demonstrated that there is a strong difference of encoding methods between genders, regardless of the existence of music [5]. The results showed

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that females tended to turn the stimulus into a more specific and less labile representation than males did. It is also worth noting that the time of the false alarm was more observed in male participants instead of female participants. Yet none of these differences were observed in the present study. One of the most plausible explanations is the limited sample size. However, in Guillem and Mograss's experiment, only twenty-six participants were measured, with sixteen males and ten females, in which the number of participants was even less than that of the present study.

Therefore, this study raises opportunities for future research directions. Larger samples and more balanced gender populations should be regulated in the replication, as well as general physical situation of individuals such as sleep quality, caffeine consumption, and stress. Cultural differences also account for different interpretations of music lyrics. Only Chinese students were measured in the present study, yet the lyrics are written in English.Verbal memory tasks may be partial for measuring cognitive abilities. Non-verbal memory tasks such as drawing geometric figures from memory (Rey Complex Figure Test) and the spatial processing task that the Angel et al. study employed. Moreover, speaking to the academic performance of the distraction task, mathematical calculations may not be the only choice. After all, the non-significant result showed promising potential to the forthcoming future directions. While considering inevitable limitations of the present study, future studies are prompted to discover more relationships between cognitive abilities and music.

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