

THE EFFECTS OF BACKGROUND MUSIC AND MUSIC LISTENING ON READING RECALL AND EXTRANEIOUS COGNITIVE LOAD

Lara Schommerloh¹, Timothy McNichols², Christine Horn², & Sean Henriques²

¹*Department of Physiology, School of Medicine, Trinity College Dublin,
The University of Dublin (Ireland)*

²*Department of Technology & Psychology, Institute of Art, Design and Technology,
Dun Laoghaire, County Dublin (Ireland)*

Abstract

Music listening is increasing worldwide due to the growing popularity of streaming services. The International Federation of the Phonographic Industry (2023) reported the highest amount of music listening measured to date, with an average listening time of 20.7 hours per week. They also found people often listen to music while completing tasks, including working. This trend suggests an increasing importance of research into background music listening and its effect on working memory. While research has been done on background music (BGM) and working memory, the results were inconclusive and mostly focused on simple memory tasks. Only recently researchers have tested the influence of BGM on working memory in more complex tasks, such as reading (Vasilev et al., 2024). As the most popular genres have a heavy focus on lyrics, the effect of lyrics in BGM on reading task performance has become an important research objective.

This experimental eye-tracking study explored the effect of lyrics in BGM and music listening frequency on reading recall ability and extraneous cognitive load. Thirty-seven participants (12 males, 18 females, 4 non-binary) with an average age of 22.2 years took part in the study. Participants were divided into two groups based on their music listening frequency (low, high) and read two text passages, one with instrumental BGM, one with lyrical BGM. While reading, their pupil diameter was measured as an indicator for extraneous cognitive load. The results indicated no effect of music listening frequency on reading recall and extraneous cognitive load. Lyrics in BGM had no effect on reading recall. However, the findings indicated an increase in extraneous cognitive load when lyrical BGM was played ($t(37) = 1.7$, $p = .049$, 95% CI = [-.003, .035]). Reading recall and extraneous cognitive load were not correlated.

This study was one of the first to explore lyrics in BGM on both working memory and extraneous cognitive load, while considering a possible effect of music listening frequency. The findings give valuable implications on music usage in an office workspace or learning environment by advancing the literature to date (e.g. Que et al., 2023; Souza & Leal Barbosa, 2023; Vasilev et al., 2024). Specifically, the findings suggest lyrics in BGM may increase extraneous cognitive load but do not influence reading recall. Hence, if reading tasks are completed without time pressure, listening to a song with lyrics compared to its instrumental version does not negatively affect reading recall ability.

Keywords: *Cognitive load, reading recall, music.*

1. Introduction

Recently, music listening has been increasing steadily worldwide due to the growing popularity of streaming services. The International Federation of the Phonographic Industry (IFPI; 2023) reported the highest amount of music listening measured to date, with an average listening time of 20.7h per week in 2023. They found that people often listen to music during activities, e.g. while working. This trend suggests an increasing importance of research into background music listening and its effect on working memory. The results of previous research on background music (BGM) and working memory were inconclusive and mostly focused on simple memory tasks. Only recently researchers have tested the influence of BGM on working memory in more complex tasks, such as reading. As the most popular genres have a heavy focus on lyrics (IFPI, 2023), the effect of lyrics in BGM on reading task performance has become an important research objective. Vasilev, Hitching, and Tyrrell (2024) looked at the impact of lyrics in BGM on self-paced reading. They found lower reading speed and reading comprehension accuracy with lyrical BGM when the songs were unfamiliar. No difference was found with familiar songs. Other studies used

eye-tracking to measure effects of BGM on cognition. Que, Zheng, Hsiao, and Hu (2023) investigated the influence of self-selected BGM on reading task performance and eye movements. Additionally, they examined individual factors such as working memory capacity and BGM listening frequency. They found no effect of BGM on reading task performance, but an increase in reading times with BGM. Eye movements indicated higher extraneous cognitive load (ECL) with BGM, although change in pupil diameter did not differ significantly between the BGM group and the group without BGM. It appears that people have implicit awareness of the negative effects of BGM on task performance and cognitive load. Souza and Leal Barbosa (2023) found that the preference of listening to less complex BGM during difficult tasks like reading aligned with the actual negative effect of lyrical BGM on reading task performance.

1.1. The present study

The present study aimed to investigate the effects of lyrics in BGM and music listening frequency (MLF) on reading recall (RR) and ECL by answering the following research question:

Do lyrics in background music and music listening frequency impact reading recall and pupil diameter?

The hypotheses for the present study were:

H1a: There will be a decrease in RR when lyrical BGM (vs. instrumental BGM) is played.

H1b: The group with high (vs. low) MLF will have higher RR scores.

H2a: There will be an increase in pupil diameter when lyrical BGM (vs. instrumental) is played.

H2b: The group with high (vs. low) MLF will have smaller pupil diameter.

H2c: There will be an interaction of BGM and MLF on pupil diameter.

H3a: There will be a negative correlation between RR and pupil diameter with lyrical BGM.

H3b: There will be a negative correlation between RR and pupil diameter with instrumental BGM.

2. Method

2.1. Design & participants

For the current study a 2x2 factorial multivariate within-between groups experimental design was applied. The independent variables for this study were BGM (2 levels: lyrical BGM, instrumental BGM) and MLF (2 groups: low, high), the dependent variables were RR and ECL. Participants were recruited on IADT campus via convenience sampling. A total of 40 participants took part. Three participants were excluded due to insufficient eye-tracking data. The remaining 37 participants (male: 12, female: 18, non-binary: 4) were between the ages of 18 and 47 years old ($M = 22.2$, $SD = 4.7$). The study was approved by the IADT Psychology Ethics Committee prior to the participant recruitment and conducted in alignment with the PSI Code of Ethics (The Psychological Society of Ireland, 2019). The study was supervised for the full duration to ensure the safety of the participants. The data was collected in alignment with GDPR guidelines. All data was anonymised using a unique identifier.

2.2. Materials/apparatus & procedure

The experiment was conducted on a PC in the Psychology lab in IADT using the Tobii Pro Spark eye-tracker. All materials were loaded into the Tobii Lab software. The data was collected using four Microsoft Forms. The participants gave informed consent to participate in the study, created their unique identifier and answered demographic questions. They then completed the questions for the Music Listening Index, a subscale of the MUSE Questionnaire (Chin & Rickard, 2012), to measure MLF. The eye-tracker was calibrated for each participant. If the calibration accuracy was above 10%, the eye-tracker was recalibrated. Participants were instructed to read two text passages of approximately 200 words (graduatehotline, n.d.-a; graduatehotline, n.d.-b) carefully. During each reading session either the instrumental or lyrical versions of Fly by Nicky Minaj, feat. Rihanna were played in the background. The order of the texts and song versions was randomized. Directly after each reading session the participants answered eight text-based multiple choice questions with five options each (“What color were the sunrises everywhere? 1. Orange, 2. Gold, 3. Persimmon orange, 4. Cantaloupe, 5. Lemon”) to measure their RR. The volume of the audio was fixed at 20%. The brightness of the screen was set to maximum. During the reading process, the participants’ pupil dilation was measured. The participants were debriefed and consented to their data being used for the study.

3. Results

A Sign Test showed no significant difference in RR based on BGM ($Z = -.171$, $p = .864$), therefore H1a was not supported. A Mann-Whitney U Test was conducted, showing no significant difference in RR based on participants’ MLF with lyrical BGM ($U = 166.5$, $p = .962$) and with instrumental BGM

($U = 137.5$, $p = .343$). Therefore, H1b was not supported. A 2-way Analysis of Variance (ANOVA) showed no significant difference in pupil diameter based on BGM ($F(1, 35) = 3.384$, $p = .074$, $pow = .432$). The mean for lyrical BGM was 2.82 (SD = .056, 95% Confidence Interval (CI) = [2.71, 2.93]), the mean for instrumental BGM was 2.8 (SD = .052, 95% CI = [2.7, 2.91]). Because the results indicated that the sample size was too small, an additional Paired Samples T-Test was conducted. The results showed a significant increase in pupil diameter with L-BGM compared to I-BGM ($t(36) = 1.7$, $p = .049$, 95% CI = [-.003, .035], $d = .279$). H2a was supported. The 2-way ANOVA showed no significant difference in pupil diameter based on MLF ($F(1, 35) = .072$, $p = .790$, $pow = .058$). Therefore, H2b was not supported. The 2-way ANOVA showed no interaction between BGM and MLF ($F(1,35) = 1.236$, $p = .274$, $pow = .191$). H2c was not supported. A Spearman Correlation showed no significant relationship between pupil diameter and RR with lyrical BGM, $r = -.079$, $p = .642$. Therefore, H3a was not supported. A Spearman correlation showed no significant relationship between pupil diameter and RR with instrumental BGM, $r = -.015$, $p = .931$. H3b was not supported.

4. Discussion

Contrary to Vasilev et al. (2024), who reported that lyrics in background music negatively influence reading comprehension, no impact on reading recall was found in the current study. The potential negative effect of lyrics on extraneous cognitive load was supported by Que et al. (2023) who found a negative impact of background music on extraneous cognitive load. No correlation was found between reading recall and extraneous cognitive load. This may be explained by longer reading durations balancing out missing working memory resources (Que et al., 2023). MLF did not appear to affect how lyrical BGM affects RR and ECL. In the previous study by Que et al. (2023) background music listening frequency was found to be related with ECL during reading tasks (Que et al., 2023). It is therefore assumable that specific music listening behaviours play a bigger role than overall music listening frequency. For future research, a bigger sample size and more robust pilot testing are recommended for the RR questionnaires to ensure a normal distribution of the data and higher reliability of results. Additionally, future research is necessary to determine how MLF and background music listening frequency differ in their impact and potential reasons why.

5. Conclusion

The findings of the current study give valuable implications on background music usage in work and study spaces. It can be assumed that, at least as long as reading tasks are completed without time pressure, listening to a song with lyrics compared to its instrumental version does not negatively affect reading recall ability.

References

- Chin, T., & Rickard, N. (2012). The music USE (MUSE) questionnaire: An instrument to measure engagement in music. *Music Perception: An Interdisciplinary Journal*, 29, 429–446. Retrieved December 18, 2024, from <https://doi.org/10.1525/mp.2012.29.4.429>
- graduateshotline. (n.d.-a). *Free online GRE Reading Comprehension Test*. Retrieved February 12, 2025, from https://gre.graduateshotline.com/reading_comprehension_practice.html
- graduateshotline. (n.d.-b). *Reading Comprehension Practice for GRE 5*. Retrieved February 12, 2025, from <https://gre.graduateshotline.com/reading-comprehension-practice-test-5.html>
- International Federation of the Phonographic Industry. (2023). *Engaging with Music 2023*. Retrieved April 11, 2025, from <https://www.ifpi.org/ifpis-global-study-finds-were-listening-to-more-music-in-more-ways-than-ever/>
- Que, Y., Zheng, Y., Hsiao, J. H., & Hu, X. (2023). Studying the effect of self-selected background music on reading task with eye movements. *Scientific Reports*, 13(1), 1704. Retrieved April 11, 2025, from <https://doi.org/10.1038/s41598-023-28426-1>
- Souza, A. S., & Leal Barbosa, L. C. (2023). Should We Turn off the Music? Music with Lyrics Interferes with Cognitive Tasks. *Journal of Cognition*, 6(1), 24. Retrieved April 11, 2025, from <https://doi.org/10.5334/joc.273>
- Vasilev, M. R., Hitching, L., & Tyrrell, S. (2024). What makes background music distracting? Investigating the role of song lyrics using self-paced reading. *Journal of Cognitive Psychology*, 36(1), 138–164. Retrieved April 11, 2025, from <https://doi.org/10.1080/20445911.2023.2209346>