Tunes and Toons: The Impact of Background Music on Motivation and Memory and the Role of the Moderator Effect Music Affinity

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Abstract

The impact of background music on memory and motivation has garnered significant attention, yet research on the direction of this relationship remains inconclusive. This study investigated the effects of background music on memory performance and motivation during a memory task, as well as the moderating role of music affinity in this relationship. Forty university students were assigned to either an experimental group exposed to classical background music or a control group who completed a memory task in silence. Linear regression analyses were conducted to examine the relationships between background music, memory performance, motivation, and music affinity. Results indicated no statistically significant relationships between background music and memory recall or intrinsic motivation. Music affinity also did not significantly moderate the relationship between background music and memory performance. These findings suggest that background music neither enhances nor impairs memory performance or motivation and it can be assumed that individual differences in musical engagement may not substantially influence these outcomes. The results challenge the assumption that background music universally enhances memory and motivation and highlight the complexity of research in that area and the need to consider individual differences. Arguments for both methodological diversity and consistency can be made, but further investigation and additional data is needed.

Table of Contents

Introduction

The influence and presence of music have always been an undeniable part of the history of human existence. As nineteenth-century poet Henry Wadsworth Longfellow said, “Music is the universal language of mankind” (Schaub, 1988).

What might sound like a romantic justification for its relevance and worship in general, has indeed been investigated scientifically in an academic context. For instance, music has positive effects on mental and physical health. Research has found positive impacts on managing stress and anxiety (De Witte et al., 2020), and several studies found that music boosts the immune system (Chanda & Levitin, 2013). Additionally, improvements in mental illnesses were observed and music is widely utilized in therapy to treat psychological malfunctions and disorders (Lin et al., 2011). Hence, direct effects on health are substantiated and music might be a variable for change within individuals.

Music can also profoundly influence emotion, eliciting a range of psychological responses across individuals. For instance, universal psychological responses to music are sadness, happiness, fear, or spirituality rooted in broader aspects of emotion, auditory perception, and other cognitive abilities originally developed for purposes unrelated to music. This development can be observed also in societies without the usage of words (Singh & Mehr, 2023). Consequently, universal psychological functions, that might be part of our genetic composition or development, enable people to be reactive to music, although it is unclear whether its role in human evolution is any adaptive or evolutionary (Cabanac et al., 2013). Those elicited emotions by music might then cause cognitive functions such as increased attention or concentration, which improve academic performance (Vigl et al., 2023). As a result, arguably music provokes a change of emotions, wherefore the incorporation of music in our lives might be useful to improve learning.

For instance, a study by Khalfa et al. (2003) investigated everyday stress associated with performance at work and school. Relaxing music prevented stress-induced increases in heart rate and systolic blood pressure compared to a silence control group. It was also found, in another study, that college students use music while studying to increase concentration on academic tasks (Kotsopoulou & Hallam, 2010). Vigl et al. (2023) also emphasize that background music, through elicited emotions, can enhance learning processes involved in academic tasks, for example involving memory. Those studies indicate

beneficial aspects and changes in cognitions such as memorization ability and focus, that might enhance or support learning and performance in an academic context.

Therefore, one of those cognitions that might be fostered with background music could be memory. Baddeley (2015) states that, within learning, memory is a fundamental cognitive process that contributes to learning and information retention. Thus, memory plays a critical role in academic performance and the ability to apply knowledge. It enables individuals to store, retrieve, and utilize information. Thus, regarding the beneficial aspects and changes in cognitions such as memorization ability, it can be argued, that background music in educational environments might enhance cognitive engagement. Hence, because of that, in an academic context, music might be a tool for optimizing cognitive processes such as memory. But how could background music possibly influence memory?

Background music can enhance memory through the emotional arousal it generates. This is because emotions play a significant role in memory formation, as they can increase attention, which is critical for encoding new information. This is done through the release of stress hormones, which lead to stronger cognitive engagement (Cahill & McGaugh, 1998). As a result, this potent emotional stimulus can trigger memorization and potentially enhance the storage and retrieval of memories.

Another possible explanation how background music might influence memory is that music has been used as a mnemonic device in educational settings for centuries (Wallace, 1994). Consequently, rhythms or melodies can be used to help students remember information. For example, children are taught the alphabet through the "ABC song". Theoretically, music aids memory by providing structure to information and structured repetition inherent in music composition aligns with how the brain encodes information, making it easier to recall (Wallace, 1994). Hence, music provides a framework that aligns with cognitive processes, allowing information to be chunked into manageable units, which enhances memory retention.

Another option to explain the relationship between background music and memory could be the environment under which memory is encoded, which can help retrieve that memory later on. Background music, being part of the sensory environment, can act as a contextual cue for recalling information. A study by Balch et al. (1992) demonstrated that participants were better able to recall information when they were in the same auditory

environment. Those explanations on how background music can enhance memory might indicate clear beneficial usage of it in, for example, schools or universities.

However, although specific types of music might help in specific contexts, the beneficial factor of background music cannot be verified by scientific literature on the relationship between background music and memory as research in that area is inconclusive. In an article by de la Mora Velasco & Hirumi (2020), they reviewed thirty studies that examined the effects of background music on learning from 2008 to 2018. Generally, much research concerns the influence of classical music on academic task performance. In particular, Mozart's "Piano Sonata No. 16 in C, K. 545" is an often-used research piece of music. It is well-suited because it has been frequently used in cognitive research due to its predictable, non-distracting structure, neutral emotional tone, and comparability (de la Mora Velasco & Hirumi, 2020; Thompson et al., 2001). Most of the thirty studies they reviewed focussed on memory retrieval tasks. Among the 18 studies that focused on background music's impact on memory or information recall, six reported negative effects, five reported positive outcomes and seven reported non-significant effects (de la Mora Velasco & Hirumi, 2020). Hence, contradictory results were found regarding the influence of background music on memorization and memory retrieval.

An explanation for these inconclusive results could be that background music might also distract and direct attention toward the sounds (de la Mora Velasco & Hirumi, 2020). In another review, Waterhouse (2006) analyzed ten studies concerning the impact of listening to Mozart's music before conducting visual-spatial tasks. The review presents contradictory findings within those studies and proposes that background music's beneficial impacts may be due to emotional arousal and further research is needed. Consequently, scientific research does not verify the enhancement of memory by background music, and further need for investigation results from a lack of substantial and consistent findings on the influence of background music on learning in general (Jäncke & Sandmann, 2010). Hence, given its crucial role in learning, understanding how external stimuli, such as background music, affect memory is relevant to investigate.

Because of inconclusive research, there may be individual differences that cause the diversity in the findings and help to explain how or why background music affects memory. Capturing this complexity, considering variables that might moderate or mediate between

background music and memory is crucial to distinguish whether observed effects are truly due to background music or other influencing factors.

Hence, inconclusive findings on the effectiveness of background music for memorization may also stem from the influence of background music on motivation to execute a memory task. Motivation, generally, can be defined as the internal process that directs goal-directed behaviour (Ryan & Deci, 2000). For instance, listening to music that a student finds enjoyable, or calming can create a positive emotional environment, promoting a focused and motivated mindset. In their study, they suggest that the impact of music on task performance is mediated by arousal and mood rather than directly affecting cognition (Hallam et al., 2002). This would mean that while music may not impact motivation outright, it plays a significant role in shaping the environment conducive to memorizing. As motivation plays a crucial role in facilitating learning and considering its resulting importance in instructional design, conclusive research needs to take into account the effects of affective features and its resulting motivation (Pintrich & Schunk, 1995). Therefore, in this research, it is relevant to control for the impact of background music on motivation and aim to better understand how individually perceived motivation is enhanced by background music, given the prerequisite that motivation enhances memorization and task performance.

Motivation is a critical variable and cognition in the relationship because it can directly influence a student's engagement, persistence, and overall performance. Many studies highlight the role of motivation in determining how much effort students invest in learning and that a motivated person will perform better on academic tasks (Pintrich & Schunk, 1995; Wigfield & Eccles, 2000). As a result, motivation is definitely an important enhancement for memorization, and the more relevant link to investigate is how far background music can influence that motivation. Therefore, considering the described influence of music on human cognition, motivation could be an internal function modifiable through background music, as background music has been shown to impact emotional states, which in turn can affect motivation.

Another variable that could moderate the relationship between background music and memory could be the effect of music affinity. In this research, music affinity refers to an individual's overall engagement with and emotional connection to music, as well as musical training (StGeorge et al., 2014). Thus, people with higher levels of music knowledge, such as trained musicians or regular listeners, may tend to process music differently than people

with low music affinity and engage more deeply with the structure of the music. In existing research, little is known about the influence of music affinity on the relationship between background music and learning (de la Mora Velasco & Hirumi, 2020). Additionally, research in that area has failed to consider differences in the subjectivity of background music perception, for example in personal preference or musical training (Hallam & MacDonald, 2014). Hence, those might be relevant variables and moderating effects when considering other influential factors, along with possible influences of music composition such as volume, genre, duration, and arousal, that are also not investigated extensively (de la Mora Velasco & Hirumi 2020).

A general lack of available studies and methodological diversity makes it difficult to determine under which circumstances the effects of background music might be positive or negative for memory. To reach transparent and replicable research, future studies need to be conducted and accurately report all included factors, variables, and effects.

Additional research and new data on the relationship between background music, its effect on motivation, and memory, as well as the influence of music affinity, are crucial for several reasons. Instructional design is a subject of change with an urgent demand for modern and valid design choices, especially considering digital learning environments. To better design instruction and equip educators with valid knowledge is, thus, important to improve the learning atmosphere and outcomes. Additionally, learning can be very individual but through further investigation and clarification of influencing factors and differences within people, it is possible to tailor educational strategies to individual preferences and needs, therefore optimizing the learning experience for different types of learners. Given these reasons, new data always contributes to a broader understanding and contemporary data can extend existing research results (de la Mora Velasco & Hirumi, 2020).

Hence, the problem within this research area is that the relationship between background music and memory is multifaceted and complex and a general positive relationship between background music and improved learning outcomes cannot be validated and existing literature reveals the need for more empirical studies to address the numerous unanswered questions and possible influential factors. Thus, this research can explore the impact of background music on memory and motivation and can include music affinity to control for previously disregarded measures of individual differences. Consequently, this additional study may indicate directive relations and tackle the

knowledge deficit in the area, which is necessary considering the importance of shaping functional instructional design within education and learning.

Therefore, building on the extensive and varied findings, this paper aims to investigate the relationship between background music and memory for university students. This investigation is expanded by exploring the relationship between background music and motivation and the moderator variable music affinity.

The first research question is, to what extent does background music influence university students' memory performance? Given the inconclusive findings and mixed results, a directive hypothesis cannot be formulated, and therefore this research opts for an exploratory analysis by exploring this possible relation.

The second research question is, to what extent does background music influence university students' motivation? Motivation is a key factor in learning, directly affecting engagement and performance. Since cognitions influenced by background music can shape motivational states (Hallam et al., 2002), the hypothesis would be that background music significantly enhances motivation.

The third research question is, to what extent does university students' music affinity influence memory performance? As so far, no effects of music affinity in the relationship between background music and memory were found and only few research is available, again, a directive hypothesis cannot be formulated. As a result, this analysis aims to explore the role of music affinity within the relationship between background music and memory, as any effect cannot be predicted.

Methods

Study design

The study followed an independent measures experimental design with two groups: The experimental group was exposed to background music while memorizing and performing a memory test. In contrast, the control group memorized and performed the memory test in silence. The independent variable (IV) was the presence of background music (BM) during memorization and the memory test. The dependent variable (DV) was memory performance, measured by the number of word pairs correctly recalled in a memory test. Additionally, two variables were measured by completing two questionnaires: The dependent variable motivation, to investigate the influence of BM (IV) on perceived motivation, and the moderator variable music affinity, to control for individual differences.

By integrating an experimental and quantitative approach, this research will seek to answer the previously stated research questions.

Participants

A total sample of 40 students (20 per group) was targeted. Due to the presence of missing values (NAs) in the dataset, which made it impossible to score the questionnaires for those individuals, three participants out of the initial sample of 40 were excluded from the final analysis. Consequently, the remaining dataset comprised 20 participants in the control group and 17 participants in the experimental group, ensuring the integrity of the data for subsequent analyses. Thus, the final sample consisted of 37 participants, including 10 males and 27 females. Participants' ages ranged from 18 to 36 years, with a mean age of 21.22 (*SD* = 3.15), as seen in Table 1.

Table 1

Demographics of the sample

Group	N	Age range	Gender (n)	Mean (Age)	SD (Age)
Control group	20	18 - 36	Male = 4, Female = 16	21.15	3.92
Experimental group	17	18 - 25	Male = 6, Female = 11	21.29	2.02
Total group	37	18 - 36	Male = 10, Female = 27	21.22	3.15

The Participants were university students from a mid-sized university in the Netherlands, recruited through a recruitment system for university studies and the personal network of the researcher. Participants were randomly assigned to the experimental or control group. All participants must have possessed the ability to hear and interpret sound at a functional level without any diagnosed auditory impairments, as the study involves background music listening as the primary independent variable. Additionally, participants must have no other diagnosed cognitive impairments. That refers to not having diagnosed

learning disabilities, ADHD, or memory disorder. This is important as any diagnosed mental condition could interfere with memory performance, making it difficult to isolate the effects of background music from the participants' cognitive limitations (Baddeley, 2003). Beforehand, the study was ethically approved by the BMS Ethics Committee of the University of Twente. Participation was voluntary, and informed consent was obtained before the experiment began and a debriefing afterward was conducted.

Materials

Word Pair Memory Test

An analogical, for this study designed, Word Pair Memory Test that consists of two parts was used to measure memory performance. In this study, in the first part, the task is to memorize a list of 30 word-pairs. Examples of word pairs are “Apple – Jacket” or “Street – Chair”. The second part of the test is a recall test, where the first or second word from each pair is provided and the corresponding second word has to be recalled, generating a total number of correctly recalled word pairs that serve as the measure of memory performance. The Word Pair Memory test can be found in Appendix A.

Background Music

For the experimental group, instrumental music was used during both the memorization and recall phases. Out of 18 studies regarding the influence of background music on memory or information recall, 11 studies have used background music throughout both phases to assess its cumulative effect on memory performance and its possible contextual memory facilitation, therefore providing a more standardized approach that allows for comparison with existing findings (de la Mora Velasco & Hirumi, 2020). Due to its established role in research on the influence of background music on cognitions and its comparability, the classical instrumental piece by Mozart “Piano Sonata No. 16 in C,K.545 “Sonata facile”: 1 Allegro” was used on repeat in this study. The music was set at a low volume to prevent auditory overstimulation and was identical for all participants in this group (Furnham & Strbac, 2002). The researchers' mobile phone and music speaker were used to play the music piece.

Intrinsic Motivation Inventory

The 22-item version of the Intrinsic Motivation Inventory (IMI) was used to assess individual motivation during the memory task (Ryan, 1982). This version has been used in many lab studies on motivation. Generally, the IMI is a well-validated instrument to measure

self-reported motivation in experimental settings (Deci & Ryan, 2000). Overall, this version demonstrated high internal reliability within previous research (Cronbach's $\alpha > 0.70$). The 22-item version of the IMI consists of 4 subscales with responses for each item scored on a Likert scale ranging from 1 (*Not at all true*) to 7 (*Very true*). The Interest/Enjoyment subscale (seven items) is considered the self-report measure of intrinsic motivation, and an example item is: "I found the task very interesting." The Perceived Choice subscale (five items) and Perceived Competence subscale (five items) are theorized to be positive predictors of both self-report and behavioural measures of intrinsic motivation. An example item for the Perceived Choice subscale is: "I felt that it was my choice to do the task." An example for the Perceived Competence subscale is: "I think I am pretty good at this task." Lastly, the Pressure/Tension subscale (five items) is considered to be a negative predictor of intrinsic motivation. An example item for this subscale is: "I felt pressured while doing the task." No changes were made to this version of the IMI. The IMI can be found in Appendix B.

Music Use Questionnaire

Music affinity was assessed using the Music Use (MUSE) Questionnaire, a widely used tool for evaluating individuals' engagement with and affinity for music (Chin & Rickard, 2012). The reduced 32-item format was used in this study, no changes to the original version were made. The MUSE Questionnaire assesses a person's musical background and preferences and the frequency of engagement with music through a series of self-report items by considering the quality and quantity of different forms of music use. Its reliability has been well-established, with a Cronbach's alpha value of 0.89 (Chin & Rickard, 2012). The questionnaire consists of three indices. The index of Music Training (10 items) captures an individual's formal and informal music training and the completion of certified examinations. An example item is: "What is the highest level of formal music training you have received?" Next, the index of Music Instrument Playing (10 items) assesses the intensity of practice. Here, an example item is: "At the peak of your interest, how many hours per day did you play/practise the music instrument (includes singing)?" Lastly, the index of Music Listening (12 items) assesses the intensity of frequent and intentional music listening. An example item question is: "On average, how many hours do you purposely listen to music a day (as opposed to music in the environment that you have no control over (e.g., music in cafes, stores)?" Responses are scored on a Likert scale ranging from 1 (*Not applicable to me*) to 6 (*Strongly agree*), 7 multiple choice questions, and 3 numerical open questions. The total

score reflects the level of music affinity (Chin & Rickard, 2012). The MUSE Questionnaire can be found in Appendix C.

Procedure

Prior to participation, all individuals where asked whether they possess diagnosed cognitive impairments and, if answered no, received a unique participant code, the study information and provided informed consent. Participants were all assessed individually, and the researcher was present in the room throughout the experiment to provide instructions.

Each participant from both groups was given the same list of 30 word-pairs to memorize during a 5-minute memorization phase. This timeframe is used because it reflects typical conditions for testing working or short-term memory, aligning with the focus of many background music studies on cognitive performance (Salame & Baddeley, 1989; Anderson, 2000). During the memorization and recall phases, participants in the background music group listened to Mozart's "Piano Sonata No. 16 in C,K. 545," while the control group completed the task in silence. After the 5-minute memorization period, participants were given a 5-minute recall phase. During this phase, they were asked to recall the second word in each pair. Therefore, they received a sheet with one word from each word-pair and had to fill out the missing word. Additionally, they had to indicate their unique participant code on this sheet, to link their questionnaire responses with the word-pair memory test. For participants in the background music group, the music continued to play throughout the recall task, while the control group performed both parts of the task in silence.

Following the memory task, participants digitally completed two questionnaires. Each participant had 15 minutes to complete both questionnaires. In both questionnaires, they had to indicate their unique participant code, to assign the data collected to each participant. First, they filled out the Intrinsic Motivation Inventory (IMI) to assess their motivation during the task. Then, they completed the Music Use (MUSE) Questionnaire, which measured their music affinity. Both questionnaires were completed individually. After completing the study, a debriefing was conducted.

Results

Before conducting the statistical analyses, the data was evaluated to ensure they met the necessary parametric assumptions required for linear regression. To ensure the validity of the linear regression analyses, the normality of the residuals was assessed. First, the

Shapiro-Wilk test was employed to statistically test for deviations from normality, concluding that the residuals do not significantly differ from a normal distribution. Next, a histogram was used to provide a graphical representation of the frequency distribution of residuals, allowing for the identification of any skewness or kurtosis. The histogram confirmed that the residuals closely resembled a normal distribution, leading to the conclusion that the data met the parametric assumptions of normality and could be reliably used for further analyses.

Background Music and Memory Performance

For the first research question, a directive hypothesis could not be made, and this analysis aimed to explore the impact of background music on memory performance. A linear regression analysis was used to test this. The descriptive statistics for research question one can be found in Table 2. Descriptive statistics showed that the mean memory test score in the experimental group (*M* = 17.88, *SD* = 5.89) was slightly higher than in the control group (*M* = 16.90, *SD* = 8.47). However, the analysis revealed that the presence of background music did not significantly predict or enhance memory performance (*ß* = 0.98, *p* = 0.69). An independent samples t-test also indicated that this difference was not statistically significant (*t*(29.90) = 0.41, *p* =.68), suggesting that background music did not have a significant impact on memory performance. The overall model explained only 0.46% of the variance in memory performance ($R^2 = 0.005$, adjusted $R^2 = -0.02$), indicating a negligible relationship between background music and memory. These results support the null hypothesis, suggesting that background music does not significantly influence memory performance.

Table 2

Descriptive Statistics Research Question 1

Parameter	Estimate	95% CI	SE	p	Std. Coef.	R2	R2 (adj.)
(Intercept)	16.90	[13.54, 20.26]	1.66	< .001	-0.06	4.60e-03	-0.02
Exp. group	0.98	[-3.98, 5.94]	2.44	0.690	0.13		

Background Music and Motivation

The second hypothesis proposed that background music would significantly enhance motivation during the memory task. Therefore, a linear regression analysis was executed to test this hypothesis. On average, the control group reported slightly higher levels of intrinsic motivation (*M* = 98.70, *SD* = 10.12) compared to the experimental group (*M* = 96.35, *SD* =

15.16). The descriptive statistics for that hypothesis can be found in Table 3. Contrary to the hypothesis, the results showed no significant effect of background music on motivation scores (*ß* = -2.35, *p* = 0.58). An independent samples t-test also revealed that there was no statistically significant difference in motivation scores between the experimental group and the control group (*t*(28.96) = −0.54, *p* = .59). Moreover, the model accounted for only 0.89% of the variance in motivation (*R^2 = 0.009*, adjusted *R^2 = -0.02*), indicating that there is no proof that background music has an impact on participants' motivation. Consequently, these findings suggest that background music does not significantly enhance motivation during cognitive tasks and, hence, support the null hypothesis.

Table 3

Descriptive Statistics Hypothesis 2

Parameter	Estimate	95% CI	SE	p	Std. Coef.	R2	R2 (adj.)
(Intercept)	98.70	[92.95, 104.45]	2.83	< .001	0.09	8.92e-03	-0.02
Exp. group	-2.35	[-10.83, 6.14]	4.18	0.578	-0.19		

Moderator Effect Music Affinity

For the final research question, no directive hypothesis could be made, wherefore the analysis aimed at exploring the moderator effect of music affinity. Thus, a linear regression analysis was used to test this. The descriptive statistics for that research question can be found in Table 4. Overall, descriptive statistics revealed that the mean music affinity score was slightly lower for the experimental group (*M* = 87.65, *SD* = 26.60) compared to the control group (*M* = 92.75, *SD* = 19.63). Regarding the moderator effect music affinity, the regression analysis indicated that total music affinity scores were not significantly associated with memory performance (*ß* = 0.08, *p* = 0.16). Also, an independent samples t-test indicates that there is no significant in memory performance between the experimental group and control group (*t*(35) = 0.05, *p* = .96). The model explained 5.59% of the variance in memory performance (*R^2 = 0.06*, adjusted *R^2 = 0.03*), which, while higher than the other models, remains small and statistically non-significant. These results suggest that music affinity does not significantly influence memory performance when exposed to background music during a memory task, supporting the null hypothesis.

Table 4

Descriptive Statistics Research Question 3

Parameter	Estimate	95% CI	SE	p	Std. Coef.	*R2*	*R2 (adj.)*
(Intercept)	10.64	[0.58, 20.70]	4.95	0.039	1.19e-16	0.06	0.03
Music Affinity	0.08	[-0.03, 0.18]	0.05	0.165	0.24		

Discussion

Key Findings and Interpretation of Results

Background Music and Memory

The first objective of the study, corresponding to the first research question was to investigate and explore the relationship between background music and memory performance. This study found that background music had no statistically significant effect on memory performance. To be precise, although participants in the experimental group recalled more word pairs on average, this result was not statistically significant. This indicates that there is no proof that background music enhances memory performance. These results imply that background music may neither enhance cognitive processes such as memorization and retrieval nor serve as a distractor that impairs these functions in controlled experimental conditions. This is in line with prior research that has identified a neutral or inconsistent relationship between background music and memory tasks. As outlined, prior incorporated research suggests that the effect of background music is complex, inconclusive, and influenced by various contextual and individual factors (de la Mora Velasco & Hirumi, 2020; Črnčec et al., 2006).

One of those individual factors or reasons why background music in itself may have no statistically significant effect on memory could be individual preferences, which refers to the personal tastes regarding their exposure to and use of background music while engaging in cognitive tasks such as studying or memorization (Hallam & MacDonald, 2014). This might play a critical role in determining whether background music serves as a cognitive enhancer or a distractor, which can be transferred to this study. Consequently, personal preference and individualistic learning strategies and processes might be essential factors to consider when investigating the relationship between background music and memory, along with other possible explanations, that could be a reason for those inconclusive findings.

Hence, there might be other reasons why background music did not lead to significantly better memorization. As the experimental group did not significantly recall more word-pairs, the auditory context under which information was encoded did not influence memorization ability. Considering the research of Wallace (1994) and Balch et al. (1992), which explored how background music could influence memory retrieval, particularly whether music could act as a contextual cue for improving recall, based on these results, it can be argued that in the memory task, background music did not function as a mnemonic device and did not serve as a contextual cue for retrieving the previously memorized word-pairs.

Another reason why background music did not enhance memory could be, as prior research has emphasized, the role of emotional arousal in memory enhancement, positing that emotions due to background music can increase attention and cognitive engagement, thereby strengthening memorization (Cahill & McGaugh, 1998). In this study, background music may not have caused emotional arousal and therefore did not enhance memorization in the experimental group, despite using Mozart's "Piano Sonata No. 16 in C, K. 545," which is recognized for its cognitive neutrality and non-distracting structure (Thompson et al., 2001). Presumably, background music's emotional impact may have not been arousing enough, limiting the background music's ability to induce the cognitive engagement necessary to influence memory performance. Nevertheless, this can only be assumed, since emotional arousal was not measured in this study. As a result, it is difficult to argue for background music's memory task enhancement and it can be assumed that the context and individual factors could be important variables that influence this relationship.

Background Music and Motivation

The second objective of this study, corresponding to the second research question, was to investigate the influence of background music on motivation. Here, background music did not necessarily contribute to increased motivation during this cognitive task. Hence, background music did not significantly influence motivation during the memory task, thus failing to support the second hypothesis that background music would enhance motivation, which is why the alternative hypothesis was rejected.

Therefore, the findings of this study challenge the assumption that auditory stimuli inherently boost motivation for cognitive activities. Here, the findings did not identify background music as a significant motivational enhancer and contrary to the expectation,

participants exposed to background music did not report significantly higher levels of motivation compared to those who completed the task in silence. This does not align with the previously reasoned link that background music might create a cognitive state which in turn enhances motivation (Hallam et al., 2002). What becomes clear is that the results might indicate the variable effects of background music on emotional and motivational states, often contingent on individual preferences and other variables (de la Mora Velasco & Hirumi, 2020; Črnčec et al., 2006).

Moderator Effect Music Affinity

The third objective of this study, corresponding to the third research question, was to explore the moderator variable music affinity within the relationship between background music and memory. Here, no significant moderating effect of music affinity on memory performance was found. This finding indicated that participants with higher music affinity scores did not perform significantly higher than those with lower levels of music affinity, regardless of background music exposure.

Considering these findings, it can be argued that individual differences in music affinity do not substantially alter the relationship between background music and memory performance, which suggests that while music affinity reflects personal engagement with music, it may not translate into a meaningful advantage or disadvantage in memory tasks involving background music. This could be the case because of the complexity of cognitive tasks and the potential for cognitive load. When background music is present, it may compete with the cognitive resources required for memory encoding and retrieval, particularly in tasks that demand sustained attention. Therefore, while individuals may feel more emotionally engaged or connected to background music they enjoy, this engagement does not necessarily enhance their ability to process complex information or improve cognitive performance in tasks requiring focused attention (Hallam et al., 2002). Moreover, studies suggest that the effect of background music on cognitive performance is context-dependent and may vary based on task characteristics rather than individual music preferences (de la Mora Velasco & Hirumi, 2020).

Thus, trained musicians or frequent listeners might not experience enhanced benefits from background music due to their familiarity with musical structure, suggesting that such advantages, if present, are not universally applicable. Those findings primarily align with prior research, which states that so far, no effect of music affinity or listening habits

influence the effect of background music on memory indirectly, although research in that area is limited and many studies did not consider this variable (de la Mora Velasco & Hirumi, 2020; Hallam & MacDonald, 2014). In that regard, this research extends the existing literature by considering the moderator variable music affinity, which has not been reported before.

Implications

The results of this study contribute to the growing body of evidence suggesting that background music's influence on memory tasks may be context-dependent and subject to the interaction of multiple variables, which is why their results differ, and little general knowledge is generated.

Background music is often associated with an application in educational settings, wherefore this study may be able to direct or give a proposal of the meaningfulness of background music`s usage in those settings. Theoretically, considering the neutral or inconsistent effect of background music on memory and cognitive tasks in general and in this study, those results challenge assumptions about its universal applicability as a cognitive enhancer (Kämpfe et al., 2011).

Therefore, from a practical perspective, these findings hold significance for educational environments where background music is commonly used to create an ambient atmosphere, for example within schools or universities. The lack of a significant effect on memory performance and motivation would suggest that background music may not provide the anticipated cognitive benefits in tasks requiring focused attention and memorization. Instead, its utility might be limited to creating a pleasant environment rather than directly improving performance or motivation, aligning with prior research on the usage of background music in educational environments (Thompson et al., 2001). Consequently, this has implications for how background music is integrated into learning strategies and instructional design, resulting in a need for a more targeted and individualized approach rather than a one-size-fits-all solution.

Generally, background music might often be perceived as a universally beneficial stimulus, but this study found that the individual differences in music affinity do not contribute to enhanced memory, but there could be other individual differences that could contribute to an effective enhancement of background music on memory and motivation. It is definitely crucial to consider the diversity of learners' preferences because this equal

balance of results within the experimental and control groups could serve as an explanation or indication for individual differences that moderate the relationship between background music, memory, and motivation.

Strengths and Contributions

This study contributes to existing data on the matter by addressing key gaps identified in prior research. First, this research contributed to the generally identified need for additional data on the relationship between background music and memory, which can also be put in the general context of background music's impact on learning. As this area of research, until now, is inconclusive any new findings and conducted studies add to the development of knowledge, consistent measurements, and new approaches, which is where this study fulfills its contribution. Hence this study is an extension to prior studies, which lies in the contribution of new empirical data to the ongoing discourse on the relationship between background music and memory, addressing a critical need and lack of data identified in the literature (de la Mora Velasco & Hirumi, 2020; Jäncke & Sandmann, 2010).

A key contribution and methodological strength of this research lies in its examination of music affinity as a potential moderating variable in the relationship between background music and memory performance. By integrating music affinity as a moderator variable and examining its interaction with background music exposure, this study provides empirical data to inform this ongoing discourse. Prior studies have largely overlooked the role of individual differences in musical preferences and experiences, instead focusing on generalized effects of background music (de la Mora Velasco & Hirumi, 2020; Hallam & MacDonald, 2014). By incorporating music affinity into the analysis, this research introduces a novel perspective, allowing for a more nuanced assessment of how individual factors may influence cognitive outcomes. Although the results indicated no significant moderating effect of music affinity on memory performance, the inclusion of this variable highlights the complexity of background music's impact and demonstrates the importance of considering personal characteristics when investigating memory enhancement strategies.

Additionally, this study's focus on motivation is different from most prior research that did not consider the impact of background music on motivation and its resulting role in the relationship between background music and memory. In this study, the scope was expanded to explore background music's potential influence on motivational states. Knowledge gained through these new findings challenges the assumption that background

music inherently enhances motivation, revealing instead that its effects may be limited or context-dependent.

Another contribution is the study's methodological rigor, particularly in its standardization of experimental conditions. Using Mozart's "Piano Sonata No. 16 in C, K. 545," as the background music ensures consistency and comparability with prior research. Thus, this standardization addresses a notable gap in the literature, where some studies use diverse and inconsistent musical selections, complicating comparisons across findings. Consequently, this research adequately reported its measurement instruments and controlled effects and may serve as a valid basis or blueprint with its methodological clarity for further investigation of this area of research.

Overall, this multidimensional focus bridges the gap between cognitive and affective domains, expanding the understanding of background music's effects beyond isolated outcomes and the study contributes to a growing, yet still limited, body of research on background music's influence on memory and motivation. Moreover, the study critically addresses the presence of null effects, challenging trivial assumptions about background music's universal positive influence.

Limitations and Future Directions

One of the primary limitations could be the sample size, which may have affected the statistical power of the analysis. Although the study included a reasonable number of participants, the sample may not have been sufficient to detect smaller but potentially meaningful effects of background music on memory and motivation. Statistical power analysis is a critical tool that could have been used beforehand to determine the adequate sample size for studies involving memory and cognitive effects of background music. Nevertheless, within the scope of this research, it was hardly manageable to collect more data and find more than 40 participants. Still, a larger sample size would increase the statistical power and the likelihood of detecting other effects, particularly for subtle or interaction effects, such as those involving music affinity as a moderating variable. Hence, future research should consider involving larger sample sizes to enhance statistical power and improve the reliability of findings.

Another limitation concerns the homogeneity of the participant group because the sample only consisted of university students. Although these individuals represent a reasonable target group, their similar demographics potentially limit the generalizability of

the findings. Moreover, subjective responses from a demographically narrow group may not fully capture the complexities of the research objectives. To clarify this line of reasoning, university students are often in academic environments where studying with background music is common, making them more accustomed to working with auditory stimuli (Ransdell & Gilroy, 2001). As a result, their responses to background music might differ from those of individuals in other demographic groups who have less experience or habitually work in silence. This familiarity may lead to a phenomenon where background music no longer provides a motivational or cognitive benefit, potentially because students have become desensitized to it over time.

Hence, measuring music affinity as a novel variable relied on self-reported measures, which are inherently subjective, and also a single questionnaire may not fully capture the intricacies of an individual's relationship with music. Therefore, another consideration for future research would be the demographical diversity of participants to capture a wider range of individual experiences and responses, such as including children or high school students.

Next, the controlled experimental design of this study, while methodologically rigorous, also presents constraints with measurement. By isolating the effects of background music in a highly structured environment, this study may not fully capture the complexity of real-world scenarios where background music is used. For example, individuals may choose the type of music that helps them to concentrate and may interact with background music differently in naturalistic settings, such as during self-directed learning or creative tasks, where contextual factors like task autonomy and environmental distractions play a significant role, as well as the factor of knowingly participating in an experimental study. Here, participants could be affected by social influence or task autonomy. Hence, in more naturalistic settings, individuals may have more control over their environment, including the ability to choose when and what type of music to listen to. This autonomy may lead to more personalized interactions with background music, allowing individuals to select music that they find motivating to concentrate. Consequently, the findings may not be entirely representative of background music's impact in everyday contexts.

Considering those limitations and suggestions for improvement it can be reasoned that, clearly, there is a pressing need for more empirical data to build a foundation of knowledge in this domain. The complexity of the topic, coupled with the inconclusive

findings in existing studies, directs future research to conduct additional research to better understand the relationships between background music, memory, and motivation. Hence, standardized and reliable instruments would be essential to ensure comparability across studies and to facilitate the accumulation of generalizable knowledge. To ensure comparability, future studies could use consistent experimental designs, including well-defined musical stimuli and validated scales for assessing dependent variables.

Nevertheless, there might be more individual differences that could be investigated, especially since the individual differences investigated in this study did not seem to have an effect on memory. Considering the individualistic aspects of this topic, assessing individual differences might be ambiguous within standardized measurements that do not capture the complexity of the relationship between background music and memory, because they may not cover certain variables. For example, to capture a broader range of factors, further moderator and mediator analyses would provide insights into how individual characteristics or environmental factors interact with background music to influence memory and motivation, which could extend existing methodology. Also, qualitative methods might be considerable when investigating individual factors within memorization or processes that enhance motivation. Therefore, the inclusion of new approaches with additional individual differences measurements, as well as consistent designs can be argued for.

Thus, certain individual differences might be interesting to investigate. An idea would be to incorporate measurements of personality traits or personality in general, which could lead to better fitting descriptions of for whom background music can be helpful within memory tasks. Additionally, it could be investigated for what kind of personality, characteristic, or trait, background music may enhance motivation. Together, potential findings could also guide practical implications for the usage of background music in educational settings, which could support a more individualistic and person-tailored inclusion of background music in, for example, school or university.

Next, cognitive styles, meaning the consistent ways how individuals process and respond to information (Sadler-Smith, 1998), may be worthwhile to investigate and measure as well, as they may play a crucial role in how background music might affect memory ability and enhancement or distraction by auditory stimuli while doing a cognitive task. One critical dimension of a cognitive style relevant to background music could be the Working Memory Capacity (WMC), which reflects an individual's ability to hold information in their mind while

performing cognitive tasks (Wilhelm et al., 2013). This might be relevant because the WMC determines an individual's ability to manage cognitive load while processing information and how focussed a person is, as well as the ability to better perform in memory tests requiring WMC (De Jong, 2010). Exploring how BM influences this capacity or how people with high or low WMC score on the word-pair memory test might be interesting suggestions for further exploration.

Furthermore, individual learning styles could be measured to investigate the influence of background music on memory by considering people who prefer, for example, to study, learn, or memorize using background music in comparison to people who prefer to do so in silence. These are only a few suggestions for further individual differences investigations, which, through moderator and mediator analyses, could provide deeper insight into the conditions under which and for whom background music is an enhancement, inhibition, or neither of both for memory and motivation.

Concluding Remarks

Hence, despite the common belief that background music can enhance memory, this research found no significant evidence to support such a claim. Therefore, the data revealed that the presence of background music did not lead to improvements in memory recall or increased motivation and the assumption that music is universally beneficial in cognitive tasks can be challenged.

Most importantly, these findings highlight the importance of considering individual differences when assessing the impact of background music on memory and motivation. A motivating learning environment and cognitive engagement are highly individual processes and are influenced by highly specific contextual factors. As a result, people’s personal preferences, personalities, emotional responses, and individual differences may all play a crucial role in determining how background music affects their ability to perform a memory task or be motivated to do so.

To conclude, this area of research is both highly engaging and essential, with this study contributing by emphasizing the limitations of drawing conclusions without accounting for individual differences, as well as stressing the significance of employing and continuing comprehensive, as well as novel measurement approaches to capture nuanced dynamics and gain valuable knowledge.

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Appendix A

Word Pair Memory Test

Apple – Jacket

Street – Chair

Biscuit – River

Book – Water

Dog – Table

Cat – Wall

Tree – Clock

Moon – Window

Bread – Mirror

Sock – Boat

Flower – Drain

Lamp – Mother

Phone – Jungle

Bucket – Subway

Hand – Summer

Disc – Bedroom

TV – Sky

Clothes – Plane

Shoe – Wings

Squid – Forrest

Spring – Sea

Beach – Fridge

Milk – Door

Store – Time

Pillow – Umbrella

Musical – Ocean

Pool - Weight

Castle – Compass

Wheel – Juice

Cherry – Computer

Participant number:

Hand –	Umbrella –
Fridge –	Ocean –
Spring –	Bedroom –
Book –	Sky –
Time –	Castle –
Phone –	Mother –
Chair –	Clothes –
Bucket –	Boat –
Clock –	Moon –
Apple –	Forrest –
Milk –	Mirror –
Dog –	Flower –
Juice –	Biscuit –
Cat –	Computer –
Wings –	Pool –

Appendix B

Intrinsic Motivation Inventory

Start of Block: Default Question Block

Please indicate your participant number (written on the consent form)

_____

Please indicate your age

_____

Please indicate your gender

- ○ Male
- ○ Female
- ○ Prefer not to say

For each of the following statements, please indicate how true it is for you, using the following scale:

	Not at all true			somewhat true			Very true
While I was working on the task I was thinking about how much I enjoyed it.	○	○	○	○	○	○	○
I did not feel at all nervous about doing the task.	○	○	○	○	○	○	○
I felt that it was my choice to do the task.	○	○	○	○	○	○	○
I think I am pretty good at this task.	○	○	○	○	○	○	○
I found the task very interesting.	○	○	○	○	○	○	○
I felt tense while doing the task.	○	○	○	○	○	○	○
I think I did pretty well at this activity, compared to other students.	○	○	○	○	○	○	○
Doing the task was fun.	○	○	○	○	○	○	○
I felt relaxed while doing the task.	○	○	○	○	○	○	○
I enjoyed doing the task very much.	○	○	○	○	○	○	○
I didnt really have a choice about doing the task.	○	○	○	○	○	○	○
I am satisfied with my performance at this task.	○	○	○	○	○	○	○

I was anxious while doing the task.	○	○	○	○	○	○	○
I thought the task was very boring.	○	○	○	○	○	○	○
I felt like I was doing what I wanted to do while I was working on the task.	○	○	○	○	○	○	○
I felt pretty skilled at this task.	○	○	○	○	○	○	○
I thought the task was very interesting.	○	○	○	○	○	○	○
I felt pressured while doing the task.	○	○	○	○	○	○	○
I felt like I had to do the task.	○	○	○	○	○	○	○
I would describe the task as very enjoyable.	○	○	○	○	○	○	○
I did the task because I had no choice.	○	○	○	○	○	○	○
After working on this task for awhile, I felt pretty competent.	○	○	○	○	○	○	○

End of Block: Default Question Block

Appendix C

Music Use Questionnaire

Start of Block: Default Question Block

Please indicate your Participant number (written on the consent form)

_____

Q1: On average, how often do you listen to music in a week?

- ○ Less than once a week
- ○ 1 – 2 times a week
- ○ 3 – 4 times a week
- ○ 5 – 6 times a week
- ○ More than 6 times a week

Q2: On average, how many hours do you purposely listen to music a day (as opposed to music in the environment that you have no control over (e.g., music in cafes, stores)?

- ○ Less than 1 hour per day
- ○ 1 – 2 hours per day
- ○ 3 – 4 hours per day
- ○ 5 – 6 hours per day
- ○ More than 6 hours per day

Q3: Have you played / do you play a music instrument (includes singing, practice, and performance)?

- ○ No (please proceed to question 7)
- ○ Yes, I've played a music instrument (please continue on to question 4)

Q4: For how many years (indicate a number) did you play a music instrument?

_____

Q5: At the peak of your interest, how many hours (indicate a number) per day did you play/practise the music instrument (includes singing)?

_____

Q6: How long since you last regularly played a music instrument (includes singing, practice, and performance)?

- ○ Less than a week ago
- ○ Less than a month ago
- ○ Less than 1 year ago
- ○ Between 1 and 5 years ago
- ○ Between 5 and 10 years ago
- ○ More than 10 years ago

Q7: What is the highest level of formal music training you have received?

- ○ None
- ○ Primary (Elementary) school music classes
- ○ Secondary (High) school lessons
- ○ Tertiary (University) undergraduate training, Conservatory of music or master classes
- ○ Postgraduate training, or advanced overseas training

Q:8 What other type of music training did you receive?

- ○ None
- ○ Self-taught (no formal training)
- ○ Private (Individual) music classes/tuition
- ○ Group music classes/tuition

Q9: Have you completed AMEB (or equivalent such as ABRSM) music examinations?

- ○ No (please continue to question 11)
- ○ Yes (please continue to question 10)

Q10: I have completed up to which grade for both Theory and Performance/Practical (please fill in the highest Grade you have completed in numbers)?

_____

Q11: Please read each statement and click the answer that best describes you

	Not applicable to me	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Music is often a source of inspiration for me	○	○	○	○	○	○
I often play challenging pieces	○	○	○	○	○	○
There is a greater connection with my friends when we like the same music	○	○	○	○	○	○
Music provides me with a good pace for exercising	○	○	○	○	○	○
Music often takes away tension at the end of the day	○	○	○	○	○	○
Performing music is emotionally rewarding for me	○	○	○	○	○	○
I often listen to new compositions	○	○	○	○	○	○
I often look forward to attending music practices with my friends	○	○	○	○	○	○
Certain type of music helps me thin	○	○	○	○	○	○
Mastering this piece of music gives me greater recognition as a performer	○	○	○	○	○	○

Having similar taste in music often helps me relate better to my peers	○	○	○	○	○	○
Dance is an expression of my feelings	○	○	○	○	○	○
I often listen to music when I'm feeling down	○	○	○	○	○	○
I often get recognition from my friends for playing in the band	○	○	○	○	○	○
I am able to make more friends when we like the same type of music	○	○	○	○	○	○
Listening to music whilst exercising often helps me exercise for longer	○	○	○	○	○	○
Specific types of music make me feel better	○	○	○	○	○	○
Being able to improvise whilst playing music gives me a great sense of satisfaction	○	○	○	○	○	○
Dancing keeps me fit	○	○	○	○	○	○
I feel good when my performance is applauded	○	○	○	○	○	○

Practice helps me improve my music playing skills	○	○	○	○	○	○
I use a particular type of music to get me through tough times	○	○	○	○	○	○
Music performance demonstrates my knowledge of music theory	○	○	○	○	○	○
Music improves my physical endurance level	○	○	○	○	○	○

End of Block: Default Question Block