The Effects of Background Music on Standardized Testing

by

Dale Clifford

A thesis presented to the Honors College of Middle Tennessee State University in partial fulfillment of the requirements for graduation from the University Honors College

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The Effects of Background Music on Standardized Testing

By Dale Clifford

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ABSTRACT

Music's effect on human cognition has only recently been studied in the past thirty years. From the effect on brain development in young musicians to the potential benefit on literacy ability of children who practice music at a young age, there is strong evidence for the effects of music on human cognition ability. Evidence for the effect of passive music listening on cognitive performance, however, remains mixed. This study examined the effect of background music individually curated towards each participant while performing on a standardized test for reading: The Nelson-Denny Reading Test (NDRT). We had over 30 different MTSU participants split among the five different groups within this experiment. Our results did not reveal any significant difference among groups. However, the small effect size suggests a trend towards larger reading rates when listening to music without lyrics, perhaps a result of less interference between language in the music and the language being read.

TABLE OF CONTEXT

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INTRODUCTION

There have been many studies that have been done on the positive effects of music. The anatomy of the brain of a musician has been shown to be more functionally connected compared to a non-musician's brain. Rats being tested for post-stroke motor dysfunction have shown improved motor function after excessive exposure to classical music (12 hours every day for two weeks straight), and children who have practiced music have been shown to have better language processing, speech perception, and overall faster language learning skills. (Gaser & Schlaug, 2003; Chen et. al., 2021; Hallam, 2010; Jäncke, 2012; Ma et. al., 2020; Swaminathan & Schellenberg, 2020). There are many reasons why this may happen, but most theories revolve around the neural circuits that handle music in the brain overlapping with others that handle cognitive function. And areas of the brain such as Broca Area, the temporal cortex, and the premotor cortex not only perform functions such as motor, auditory, and visual, but they are also stimulated by music (Fadiga, Chaighero, & D'Ausilio, 2009; Hernandez-Ruiz, 2017; Sievers et. al., 2021; Das, Gupta, Neogi, 2020). This shows how much music can have an impact on the brain. Training with music adapts and changes the structure of the brain, and just listening to music can stimulate multiple areas at once (Norgaard, Stambaugh, & McCranie (2019)). It cannot simply just be the neural stimulation though. If that were the case, any music would do. One researcher, Aniruddh D. Patel, thought this as well.

Patel (2011) suggested the OPERA hypothesis for how music training can predict speech development. Music **O**verlaps with multiple neurons that help with

cognitive functions as aforementioned literature stated. **P**recision means that music requires a higher demand on sections of the brain than language does. **E**motion was very important to this study as it means that the music people listen to must have a positive effect on them to fully stimulate multiple populations of neurons in the brain. If a person does not like rap music for instance, it will not stimulate many neurons. **R**epetition shows that just playing a song one time does not help, but that the musician must play the music repeatedly to have any effect. **A**ttention is the final part of the OPERA hypothesis, stating that individuals must be able to put their full attention into music training to have the best effect. So, music training has a positive correlation with language development, a cognitive ability that goes on to help with standardized testing.

Cognition is the process of doing conscious intellectual activity such as remembering or reasoning (Merriam-Webster). It is believed that there are two constructs that help to stimulate cognition: the amount of reaction a stimulus has on a person and if it is pleasing or not (Eskine et. al. (2018)). So, while a test may evoke a big reaction, it may not be pleasing at all and would not activate cognition as well. So, how does one make an exam produce positive stimuli?

Franziska Goltz and Makiko Sadakata (2021) conducted a study on the effects of background music on cognitive performance that showed its various positive and negative effects on reading comprehension, which was my focus on this thesis. They proposed that attributes like extraversion, a great working memory, and just the distracting nature of up-beat music can lower a person's ability to maintain any material they have read. Furthermore, Goltz and Sadakata also mention how tempo and

loudness could cause impairments. This does contradict a few of the points Eskine's team of researchers made, showing that there are not many overall concrete studies on the effects of music on people's psyche. There are so many specific factors that can play into how a piece of music can be received. The complexity of some music, the tonal structure, key signature of a piece can even be a factor that could end up having negative effects on people and how their cognitive abilities are affected. With all of this in mind, it will be difficult to be able to select music that would stimulate the areas that handle cognition without having some sort of detriment to them. So, if it is not possible to say, "Which specific music would help the best during test-taking?", then what can be said?

Hypothesis

Based on the research reviewed so far, if one plays up-beat music in a major key that gives a person a pleasing experience, one expects a strong increase of cognitive ability and enhance recall ability. But, while any up-beat music could produce a boost in cognitive ability, it will be heightened based on the person's preferences and history with music. For example, individuals who prefer classic rock music over country music will get a greater cognitive boost from the music they prefer because it gives them a more pleasing reaction than other music. In sum, the music a person likes gives a more positive reaction and may stimulate areas for cognition stronger. However, the question remains unanswered as to whether the type of music goes beyond just giving the most prominent cognition boost. Another research question of interest we tackled in our research was the effect of the presence of lyrics, as one may argue that lyrics in songs would be more distracting than instrumental tracks of the same songs.

We addressed this research question by examining performances on a standardized test administered in five different music background contexts: A control group with no music, music one likes to listen to everyday with lyrics, music one listens to everyday without lyrics, music one listens to while studying with lyrics, and music one listens to while studying without lyrics. This will not only minimize the multitude of variables that may influence music down to just two, but it also brings the topic into a more understandable field for people. Based on the aforementioned literature, I hypothesized that the most beneficial music for increasing cognitive ability is the music a person will study to without lyrics.

METHODS

Participants

Thirty-one MTSU students (24 Female, 5 Male, & 2 Other) were recruited through word-of-mouth and email recruitment by the Honors College. The average age of the participants was 21 years old.

Survey

The first step in this study was to find out each participant's preferred music choice. Each participant was sent an online survey that asked them to provide a genre they would normally listen to in their everyday lives and provide examples of artists/bands from that genre they particularly enjoyed. Then they were asked the same question except it related to what music genre they would normally listen to study with. We gave the participants the choice of the top 10 highest-selling genres in 2021 as having the question be open-ended would lead to more diversity than time would allow. While it is possible that there are cases where the two answers would be the same, we

found that many times the answers differed from each other even if it was just a change in artist/bands. From there, the participants were randomly assigned into one of five groups (control, everyday w/ lyrics, everyday w/o lyrics, study w/ lyrics, study w/o lyrics) for in-person testing.

Nelson-Denny Reading Test

The Nelson-Denny Reading Test is a three-part English Comprehension and Application test that tests vocabulary understanding, reading comprehension, and reading rate (estimated words per minute). Each participant was given 35 minutes overall (15 minutes for Vocab and 20 minutes for Reading Comprehension and Reading Rate collectively) to take the exam. While the exam was being administered, the instructor would play a corresponding music playlist that matched the results given by the participant.

Music and Environment

Each music playlist was made on Spotify and played through a small Bluetooth speaker set at volume level five out of ten. This would ensure that the music was loud enough to be noticeable but not loud enough for it to be overpowering. This effect would also be accomplished by having every test be administered in a soundproof room to remove the distraction of outside noise and make the music the most prominent sound in the room.

RESULTS

The effect of music on standardized testing scores was calculated through a one-way ANOVA test (with Group as a between-subject factor) separately for the three areas tested in the NDRT: Vocabulary, Reading Comprehension, and Reading Rate. Partial eta

squared (η^2) were used to report effect sizes for each analysis ($\eta^2 = 0.01$, $\eta^2 = 0.06$, and $\eta^2 > 0.14$ are considered small, medium and large effect sizes, respectively)

Vocabulary

See Table 1 and 2 for the descriptive statistics and one-way ANOVA test for Vocabulary. Results did not reveal any significant difference ($F= 0.361$, $p=0.834$), suggesting that the data is consistent with the null hypothesis. However, they were associated with a small effect size ($\eta^2=0.053$).

Table 1

Descriptive Statistics

	Vocabulary				
	Control	**everyday w lyrics**	**study w lyrics**	**study wo lyrics**	**everyday wo lyrics**
Valid	6	7	6	6	6
Mean	50.000	49.143	54.667	56.667	51.667
Std. Deviation	17.516	14.645	12.111	10.250	9.585
Range	45.000	37.000	35.000	31.000	24.000
Minimum	22.000	27.000	33.000	44.000	42.000
Maximum	67.000	64.000	68.000	75.000	66.000

Table 2

ANOVA

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Group	251.917	4	62.979	0.361	0.834	0.053
Residuals	4538.857	26	174.571			

Note. Type III Sum of Squares

See Table 3 and 4 for the descriptive statistics and one-way ANOVA test for Reading Comprehension. Results of the ANOVA did not show any statistical significance ($F=1.521$, $p=0.225$),suggesting that the data is consistent with the null hypothesis. The estimated effect size was large ($\eta^2=0.19$).

Table 3

Descriptive Statistics

	Reading Comprehension				
	Control	**everyday w lyrics**	**study w lyrics**	**study wo lyrics**	**everyday wo lyrics**
Valid	6	7	6	6	6
Mean	28.667	26.714	29.000	33.333	32.000
Std. Deviation	6.282	6.211	6.928	3.266	3.347
Range	16.000	19.000	19.000	9.000	10.000
Minimum	20.000	17.000	16.000	28.000	26.000
Maximum	36.000	36.000	35.000	37.000	36.000

Table 4

ANOVA

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Group	182.098	4	45.525	1.521	0.225	0.190
Residuals	778.095	26	29.927			

Note. Type III Sum of Squares

See Table 5 and 6 for the descriptive statistics and one-way ANOVA test for Reading Rate. Results did not reveal any statistical significance ($F=2.022$, $p=0.121$), but the data was associated with an estimated large effect size ($\eta^2=0.237$).

Table 5

Descriptive Statistics

	Reading rate				
	Control	**everyday w lyrics**	**study w lyrics**	**study wo lyrics**	**everyday wo lyrics**
Valid	6	7	6	6	6
Mean	198.333	234.000	221.500	268.667	293.833
SD	62.877	70.991	70.662	78.227	35.159
Range	179.000	184.000	178.000	206.000	89.000
Minimum	138.000	151.000	123.000	165.000	246.000
Maximum	317.000	335.000	301.000	371.000	335.000

Table 6

ANOVA

Cases	Sum of Squares	df	Mean Square	F	p	η²
Group	34767.968	4	8691.992	2.022	0.121	0.237
Residuals	111749.00	26	4298.038			

Note. Type III Sum of Squares

DISCUSSION

The effects of background music do have an effect on individuals as seen in the research done by Goltz and Sadakata (2021) through their own reading comprehension studies of music. That much is clear. However, it cannot be said for the test we laid out.

Our research did not prove the null hypothesis to be true, that adding background music to a standardized testing environment did not improve any of the music group's test scores compared to the control group's test score to a statistically significant degree. While some may have improved or have been diminished because of the adding of preferred music, there is not enough data to prove this claim to be true or not. Furthermore, with aforementioned studies, most of the proven theories put a precedent on preference to music, showing that having background music while working on comprehension tasks or memorization of material can be improved if the music the individual is listening to is their preferred choice of music.

There were findings with the reading rate group that, while not statistically significant, do show some weight to this study. View Table 7 to see a mean comparison chart for reading rate groups. This compares the average mean of reading rate scores from the control group to the four different music groups. There is a full standard deviation difference between the mean of the control groups and the mean of the music groups without lyrics. This could lead to substantial findings later on with more participants; however, this is not guaranteed.

Table 7

		Mean Difference	Cohen's d
Control	everyday with lyrics	-35.667	-0.544
	study with lyrics	-23.167	-0.353
	study without lyrics	-70.333	-1.073
	everyday without lyrics	-95.5	-1.457

Strengths

The use of a standardized test helped to make scoring easy and allowed for the data to not be open for interpretation. There were no questions on what the data was saying as opposed to an open-ended cognitive test where it would be more difficult to see if there was a reaction to the music or not. Plus, this study focuses on the benefits in the American school system where placement exams are mostly multiple-choice questionnaires. Also, the diversity of music choices in each of our groups was a plus to see. If the study music without lyrics groups only consisted of individuals who listened to classical music while testing, even if there was significant data, it is a major threat to how the sample reflects the population, so it would not be applicable.

Limitations

With such a small participant rate, it was very unlikely that we would find any statistically significant data from any of the different independent variables. Though, with a small effect size, there is a possibility that music would have an effect with a larger effect size. Also, due to the recruiting process which was unable to gain any participants through the SONA research pool, the average Reading ACT scores of each participant was roughly 29 where the national average is at 21. This tells us that the participants tested would be very used to this structure of test so the music may end up being a non-factor with how accustomed the participant would be to this type of test.

Future Changes

If this study were to be done again, there are many changes that could be made to optimize the results. Pulling from a more diverse participant pool would benefit external validity as the sample population from this study did not reflect the overall population. Changing the testing format to be within-subject instead of between subjects would increase overall validity of the study and make it easier to show individuals increases or decreases in cognitive ability with the presence of music. And, while the NDRT does help make scoring easier, the test alone is tedious to say the least. It would be beneficial to include other cognitive activities that are more engaging because just using a standardized test may lower a person's interest and thus music would not have as much of an effect.

CONCLUSION

Music is very influential to our daily lives. It can help to liven a mood with a fast up-beat rhythm. At a young age, music can help develop different areas of the brain to help their language skills (Gaser & Schlaug, 2003). And, while we were not able to prove how it may help improve standardized testing, it has been proven in the past to have both a positive and negative effect on reading comprehension (Goltz & Sadakata, 2021). Our research did not have the time it needed to gain enough participants to suggest anything, even if we found statistically significant data. Bottomline, as other similar studies have shown, the effect music can have with standardized testing all comes down to preference.

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APPENDICES

APPENDIX A: Consent Form

The following information is provided to inform you about the research project in which you have been invited to participate. Please read this disclosure and feel free to ask any questions. The investigators must answer all of your questions and please save this page as a PDF for future reference.

- Your participation in this research study is voluntary.
- You are also free to withdraw from this study at any time without loss of any benefits.

For additional information on your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance (Tel 615-494-8918 or send your emails to irb_information@mtsu.edu. (URL: http://www.mtsu.edu/irb).

Please read the following and respond to the consent questions in the bottom if you wish to enroll in this study.

1. **Purpose**: The purpose of this study is to examine whether music listening may improve standardized testing scores.
2. **Description**: You will be asked to complete this Google Survey about your music preferences. Then, you will be contacted to schedule an in-person session on the MTSU campus to complete a series of language and reading tests. At the end of this consent form, we are also asking permission to access your ACT scores (if on file at MTSU). All the information you provide to us (answers to the survey and tests, ACT scores) will be stored without any identifiable information.

3. **IRB Approval Details**:

o Protocol Title: Can Music Help Performance During Standardized Testing?

o Primary Investigator: Dale Jarod Clifford

o PI Department & College: Psychology, College of Behavioral and Health Sciences

o Faculty Advisor (if PI is a student): Dr. Cyrille Magne

o Protocol ID: ____ Approval Date: ____ Expiration Date: ____

4. **Duration**: The whole activity should take about 60 minutes.

5. **Here are your rights as a participant**:

- Your participation in this research is voluntary.
- You may skip any item that you don't want to answer, and you may stop the experiment at any time (but see the note below)
- If you leave an item blank by either not clicking or entering a response, you may be warned that you missed one, just in case it was an accident. But you can continue the study without entering a response if you didn't want to answer any questions.
- Some items may require a response to accurately present the survey.

6. **Risks** & **Discomforts**: The risk involved is minimal. It is no more than one would experience in daily life activities. You will have to sit for up to 45 minutes at a time, which might be tiring or annoying. It is possible that discomfort could stem from the test if the participant has experienced test anxiety in the past. Your answers on the survey and behavioral tests will be given a code unrelated to your identifiable information. Only the study staff will know the code.

7. **Benefits**:

a. Benefits to you that you may not receive outside this research: This study gives you the opportunity to be involved in scientific research. This may help you better understand the scientific method and possibly feel more knowledgeable about science.

b. Benefits to the field of science or the community: The results of this study will lead to a greater understanding of the cognitive factors contributing to individual differences in language skills and testing abilities.

8. **Identifiable Information**: You will NOT be asked to provide identifiable personal information.

9. **Compensation**: If you enrolled in the study using the Psychology SONA system, you will receive up to 2 class credits.

Compensation Requirements:

a) ***The qualifications to participate in this research are the following***: ***be a native speaker of English***, ***have normal or corrected-to-normal vision*** (***e.g.***, ***glasses***, ***contact lenses***), ***and have no hearing impairment***. ***If you do not meet these qualifications***, ***you will not be included in the research and you will not be compensated***.

b) ***Please do not participate in this research more than once***. ***Multiple attempts to participate will not be compensated***.

c) ***To be compensated***, ***you must receive a completion code that will be provided to you at the in-person study session***.

10. **Confidentiality**: All efforts, within reason, will be made to keep your personal information private but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, if you or someone else is in danger or if we are required to do so by law.

11. **Contact Information**: If you should have any questions about this research study or possibly injury, please feel free to contact Dale Jarod Clifford by telephone 615-920-6165 or by email djc6p@mtmail.mtsu.edu OR my faculty advisor, Dr. Cyrille Magne, at 615-898-5599 or Cyrille.Magne@mtsu.edu. You can also contact the MTSU Office of compliance via telephone (615-494-8918) or by email (compliance@mtsu.edu). This contact information will be presented again at the end of the experiment.

You are not required to do anything further if you decide not to enroll in this study. Just quit your browser. Please complete the response section below if you wish to learn more or you wish to part take in this study.

APPENDIX B: IRB Approval Form

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129
FWA: 00005331/IRB Regn.: 0003571

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN007 – EXEMPTION DETERMINATION NOTICE

Monday, May 02, 2022

Protocol Title	***Can Music Help Performance During Standardized Testing?***
Protocol ID	**22-1146 2qi**
Principal Investigator	**Dale Clifford** (Student) *Faculty Advisor:* Cyrille Magne
Co-Investigators	NONE
Investigator Email(s)	*djc6p@mtmail.mtsu.edu; cyrille.magne@mtsu.edu*
Department/Affiliation	Psychology

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXEMPT** review mechanism under 45 CFR 46.101(b)(2) within the research category ***(2) Educational Tests, surveys, interviews or observations of public behavior*** *(Qualtrics Survey followed by Observation).* A summary of the IRB action and other particulars of this protocol are shown below:

IRB Action	**EXEMPT from further IRB Review** Exempt from further continuing review but other oversight requirements apply
Date of Expiration	**8/31/2023** *Date of Approval:* **5/2/22** *Recent Amendment:* **NONE**
Sample Size	TWO HUNDRED (200)
Participant Pool	**Healthy adults (18 or older) – Native English speakers with healthy vision and hearing**
Exceptions	Online consent followed by internet-based survey using Qualtrics is permitted.
Type of Interaction	☐ Non-interventional or Data Analysis ☒ Virtual/Remote/Online Interview/survey ☒ In person or physical– Mandatory COVID-19 Management (refer next page)
Mandatory Restrictions	**1. All restrictions for exemption apply.** **2. The participants must be 18 years or older.** **3. Mandatory ACTIVE informed consent.** **4. Identifiable information, such as, names, addresses, and voice/video data, must not be obtained.**
Approved IRB Templates	*IRB Templates:* Recruitment Email, SONA Script and Online Informed Consent *Non-MTSU Templates:* Recruitment Script(s)
Research Inducement	Class credit (2) for SONA enrollees and NONE for others
Comments	NONE

Summary of the Post-approval Requirements: The PI and FA must read and abide by the post-approval conditions (Refer "*Quick Links*" in the bottom):

- ***Final Report:*** The Faculty Advisor (FA) is responsible for submitting a final report to close-out this protocol before 8/31/2023; if more time is needed to complete the data collection, the FA must request an extension by email. REMINDERS WILL NOT BE SENT. **Failure to close-out (or request extension) may result in penalties** including cancellation of the data collected using this protocol or withholding student diploma.
- ***Protocol Amendments***: IRB approval must be obtained for all types of amendments, such as:
  - Addition/removal of subject population and sample size.
  - Change in investigators.
  - Changes to the research sites – appropriate permission letter(s) from may be needed.
  - Alternation to funding.
  - Amendments must be clearly described in an addendum request form submitted by the FA.
  - The proposed change must be consistent with the approved protocol and they must comply with exemption requirements.
- ***Reporting Adverse Events:*** Research-related injuries to the participants and other events , such as, deviations & misconduct, must be reported within 48 hours of such events to compliance@mtsu.edu.
- ***Research Participant Compensation:*** Compensation for research participation must be awarded as proposed in Chapter 6 of the Exempt protocol. The documentation of the monetary compensation must Appendix J and MUST NOT include protocol details when reporting to the MTSU Business Office.
- ***COVID-19:*** Regardless whether this study poses a threat to the participants or not, refer to the COVID-19 Management section for important information for the FA.

COVID-19 Management:
The FA must enforce social distancing guidelines and other practices to avoid viral exposure to the participants and other workers when physical contact with the subjects is made during the study.

- The study must be stopped if a participant or an investigator should test positive for COVID-19 within 14 days of the research interaction. This must be reported to the IRB as an "adverse event."
- The FA must enforce the MTSU's "Return-to-work" questionnaire found in Pipeline must be filed and signed by the investigators on the day of the research interaction prior to physical contact.
- PPE must be worn if the participant would be within 6 feet from the each other or with an investigator.
- Physical surfaces that will come in contact with the participants must be sanitized between use
- **FA's Responsibility:** The FA is given the administrative authority to make emergency changes to protect the wellbeing of the participants and student researchers during the COVID-19 pandemic. However, the FA must notify the IRB after such changes have been made. The IRB will audit the changes at a later date and the PI will be instructed to carryout remedial measures if needed.

Post-approval Protocol Amendments:
The current MTSU IRB policies allow the investigators to implement minor and significant amendments that would not result in the cancellation of the protocol's eligibility for exemption. ***Only THREE procedural amendments will be entertained per year*** *(changes like addition/removal of research personnel are not restricted by this rule).*

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Post-approval IRB Actions:
The following actions are done subsequent to the approval of this protocol on request by the PI or on recommendation by the IRB or by both.

Date	IRB Action(s)	IRB Comments
NONE	NONE.	NONE

Mandatory Data Storage Requirement:
All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data must be stored for at least three (3) years after the study is closed. Additionally,

the Tennessee State data retention requirement may apply (*refer "Quick Links" below for policy 129*). Subsequently, the data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects. **The IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this notice**. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php
- Exemption Procedures: https://mtsu.edu/irb/ExemptPaperWork.php
- MTSU Policy 129: Records retention & Disposal: https://www.mtsu.edu/policies/general/129.php

APPENDIX C: Link to Online Survey

https://forms.gle/sbrNBapWUXS59Ciq9