The Effects of Music Genre on Mathematical Performance

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Abstract

Music has become a far more regular part of daily life. Studies done with college students have found no effect of background music volume on task performance (Wolfe, 1983), while literature reviews have found a small effect of background music on mathematical performance (Vaughn, 2000). Our study aimed to examine the effect that a particular music genre would have on a participant's performance in a simple mathematics quiz. Our hypothesis, similar to what previous research had found, was that a slow or soothing genre of music would lead to a higher performance. We asked participants to listen to a randomly-assigned genre while completing the math portion of the survey. Our final examinations of the data found no significant effect of music genre on mathematical performance. When evaluating our findings, we saw several limitations within the survey design and questioned the statistical validity of our results due to sample size. With this, we concluded that more research on the topic of music genre and educational performance is necessary to understand its connections.

Keywords: *music, genre, mathematical performance*

Many students find themselves listening to music as they complete school tasks. From mathematics to reading to data analysis, background noise can help make an arduous task more entertaining. There comes an issue when choosing what genre of music to listen to, as faster and louder-paced music has been shown to negatively impact cognition. The research done has been primarily focused on those with prior musical training or those considered adolescents, with a lack of proper research on adults. Our study was designed with that shortfall in mind: what is the impact of music genre on cognitive abilities in those over eighteen years old? Does a slower-paced music track aid in brain functioning, or will it simply put participants to sleep?

Research done on the potential effects of music on short-term and long-term educational achievements shows a possible positive effect of prior musical training on cognitive tasks. A study by Wolfe (1983) recruited two hundred college undergraduates for a random-assignment experiment on the effect of background music volume on task performance. Participants were divided into four conditions: 1) completing the task without music, 2) completing the task with background music at a soft loudness (60-70 dB), 3) completing the task with background music at a moderate loudness (70-80 dB), and 4) completing the task with background music at a loud loudness (80-90 dB). The study found no significant difference in the number of completed math problems or in the number of correct answers across conditions. While the volume of music did not significantly impact task performance, participants' perceived impact of music volume on their performance differed significantly. Similarly, in a literature review by Yang (2015), data was analyzed to explore the impact of musical training on educational achievements. A hypothesis was made that childhood music interaction positively impacts adolescent education. A majority of previous literature supported the hypothesis, and a general positive correlation was found between musical training and cognitive-based educational achievements. A stronger argument could be made for a causal interaction between the two, as experiments with randomized music treatment and pre- and post-tests of intelligence showed significant results.

While the studies of Wolfe (1983) and Yang (2015) were focused on mathematical performance, a literature review by Ferreri and Verga (2016) found that research has provided conflicting results on the effect of music on memory and verbal learning. Prior research suggested that music's effects on cognitive functioning strongly relied on experimental factors. Cognitive performance has also been shown to be impacted by the personality traits of the participants, leading to low statistical validity. Most prior research has been measured by self-report or behavioral measures, furthering the lack of statistical validity. While this was true of the data reviewed by Ferreri and Verga (2016), a study by Haning (2016) reviewed previous literature that suggested music processing skills used similar areas of the brain as motor skills. Most of the previous literature studied the effects of music training on applied language skills in children, but very little research exists for adults. The results of the study showed no significant difference between those with prior musical training and those without. Though research on children consistently shows a positive correlation between music training and linguistic abilities, results for adults remain far more mixed.

Background music has been shown to somewhat improve cognition and task performance, however, its effect on mathematical performance has not yet been discussed. What could the impact of this background noise be on the brain when completing more complex tasks? Boettcher et al. (1994) reviewed previous research and found low correlations between computational and musical ability in children. Researchers interviewed fourteen mathematics professors using a list of questions related to cognition and mathematics. In response to the question, "Do you believe there is a relationship between music and math?" some professors stated that the connection is likely cognitive, involving the detection of patterns and aesthetics in both music and mathematics. A literature review by Vaughn (2000) similarly reviewed previous research on the relationship between music and mathematics. Data was analyzed in eight correlational studies that examined the math outcomes of students who chose to study music. Five experimental studies tested the hypothesis that music instruction positively impacts mathematical performance. Twelve experimental studies tested whether the type of background music played during an experiment affects math test performance. Researchers found a moderate positive association between voluntary music study and mathematical achievement; however, they have not ruled out other explanations. The positive effect size reviewed supported but did not prove the claim that music involvement improves mathematical achievement. Researchers concluded that further studies are necessary to establish a positive correlation between mathematics and music instruction. The hypothesis that background music or sound enhances arousal and thus improves task performance was not supported. The results only indicate a small positive effect of background music on mathematical test performance.

Overview of Current Study

Our study researched the effects of music genre on mathematical performance. Participants were assigned a musical genre and given a 10-question researcher-designed mathematics test while listening to their given music. Three different genres of music were chosen: 1 - Upbeat, 2 - Classical, and 3 - White Noise. No condition was made for silence. Our study hypothesized that a slow/soothing genre of music would have a positive impact on mathematical performance. Previous findings somewhat supported our hypothesis when relating to the music genre and its benefits on mathematical performance, but no significant data was found.

Methods

Participants

By the end of data collection and cleaning, we had 106 valid responses to use for analysis. Each participant was asked to consent to the given data being used as part of this study, as well as confirm they were at least eighteen years of age. The gender breakdown of participants was 32 male, 66 female, and 8 non-binary/self-identified. The age range was between 18 and 77, with a mean of 31.30 (SD = 16.23). Participants were recruited by an online survey, distributed through Snapchat, text messages, and word-of-mouth. For further information on calculated descriptive statistics, see Table 1.

Materials

Our survey was created on Qualtrics (2020) software. The final survey contained three questions on demographics, ten mathematical questions, and two consent/debrief questions (see Appendix A). Following the demographics questions, participants were randomly assigned to one of three genres of music to listen to during the mathematical performance questions (see Appendix B). These genres were Upbeat, Classical, and White Noise (see Appendix C). The goal of these levels was to determine the impact of music genre on mathematical performance.

Design and Procedure

Our study was a between-subjects convenience-sample research design. Data was collected through an online survey. Debriefing was performed at the end of the survey to inform participants of the purpose of our survey (see Appendix A). The average time spent completing the survey was 224.62 seconds, or 3.74 minutes (SD = 196.01). For further information on calculated descriptive statistics, see Table 2.

Data Analysis

Our survey contained a short mathematical test to examine the impact of music genre on test performance. Our data was self-reported due to an online survey for participant response collection. The only changes made to the collected data were the deletion of invalid responses prior to data analysis or improper manipulation checks (see Appendix D). We used IBM (2023) software to calculate descriptive statistics of participant demographics, as well as perform a One-Way ANOVA and Tukey HSD Post Hoc Test, to determine the significance of our results (see Table 3 for One-Way ANOVA, Table 4 for ANOVA Effect Sizes, and Table 5 and Table 6 for Tukey HSD Post Hoc Results).

Results

When calculating the data, we focused on each group separately from one another. Demographics were not included in the final data analysis, as they were not the main focus of the study. Based on the analyses, our hypothesis was not supported. A sample of 106 participants were randomly assigned to one of three conditions for the independent variable. The Upbeat condition had 34 participants and recorded a mean score of 8.21 (SD = 2.20). The Classical condition had 40 participants and recorded a mean score of 5.58 (SD = 2.11). The White Noise condition had 32 participants and recorded a mean score of 7.13 (SD = 1.95). (See Table 7 for final score data, and Figure 8 for a bar graph of mean scores). A one-way ANOVA for independent samples indicated that music genre had no impact on mathematical performance, $F(2, 103) = 2.23$, $p = .112$, $\eta^2 = .042$, 95% CI [0, .13].

Discussion

The data collected from our study showed no effect of music genre on mathematical performance. The sample size gathered made for little statistical validity, as well. No significant data was found in comparison to previous literature on the subject, such as the literature review by Vaughn (2000). We were faced with limitations when reviewing our study as a whole. When designing our study, we created White Noise as a control group for the independent variable. The math test given to participants lacked validity due to being researcher-designed for the purpose of this study. We were unable to find a validated math test that suited the pruposes of our sstudy. Due to our data being a convenience sample with a large age range, it lacks generalizability to a particular group. Data was also self-report, and genres used for the manipulation check were vague and often incorrectly reported by participants. Time and resources for data collection were limited, so we did not achieve the number of participants to gain proper statistical power.

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Statistics

		Gender	EduLevel	Age
N	Valid	106	106	106
	Missing	0	0	0
Mean		1.7736	6.8774	31.3019
Std. Deviation		.57376	1.54120	16.23410
Skewness		.036	.941	1.171
Std. Error of Skewness		.235	.235	.235

Figure 1

Descriptive Statistics of Gender, Education Level, and Age

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
PerformedBetter	106	1.00	4.00	1.6792	.52639	.233	.235
Genre	106	1.00	3.00	1.7264	.72418	.469	.235
Condition	106	1.00	3.00	1.9811	.79260	.034	.235
Score	106	2.00	10.00	7.6415	2.11655	-.468	.235
DurationSeconds	106	88.00	1829.00	224.6226	196.00964	5.918	.235
Valid N (listwise)	106						

Figure 2

Descriptive Statistics of Duration Spent on Survey

ANOVA

Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	19.544	2	9.772	2.233	.112
Within Groups	450.834	103	4.377		
Total	470.377	105			

Figure 3

One-way ANOVA for Independent Samples Output

ANOVA Effect Sizes[a,b]

		Point Estimate	95% Confidence Interval Lower	95% Confidence Interval Upper
Score	Eta-squared	.042	.000	.126
	Epsilon-squared	.023	-.019	.109
	Omega-squared Fixed-effect	.023	-.019	.108
	Omega-squared Random-effect	.011	-.010	.057

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.

b. Negative but less biased estimates are retained, not rounded to zero.

Figure 4

Oneway ANOVA Effect Sizes Output

Multiple Comparisons

Dependent Variable: Score

Tukey HSD

(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Upbeat	Classical	.63088	.48802	.402	-.5297	1.7914
	White Noise	1.08088	.51528	.095	-.1445	2.3063
Classical	Upbeat	-.63088	.48802	.402	-1.7914	.5297
	White Noise	.45000	.49619	.637	-.7300	1.6300
White Noise	Upbeat	-1.08088	.51528	.095	-2.3063	.1445
	Classical	-.45000	.49619	.637	-1.6300	.7300

Figure 5

Tukey HSD Multiple Comparisons Output

Score

Tukey HSD[a,b]

Condition	N	Subset for alpha = 0.05 1
White Noise	32	7.1250
Classical	40	7.5750
Upbeat	34	8.2059
Sig.		.083

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 35.021.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Figure 6

Tukey HSD Output Table

Descriptives

	Condition			Statistic	Std. Error
Score	Upbeat	Mean		8.2059	.37711
		95% Confidence Interval for Mean	Lower Bound	7.4387	
			Upper Bound	8.9731	
		5% Trimmed Mean		8.4052	
		Median		9.0000	
		Variance		4.835	
		Std. Deviation		2.19889	
		Minimum		2.00	
		Maximum		10.00	
		Range		8.00	
		Interquartile Range		4.00	
		Skewness		-1.114	.403
		Kurtosis		.388	.788
	Classical	Mean		7.5750	.33376
		95% Confidence Interval for Mean	Lower Bound	6.8999	
			Upper Bound	8.2501	
		5% Trimmed Mean		7.6667	
		Median		8.0000	
		Variance		4.456	
		Std. Deviation		2.11087	
		Minimum		3.00	
		Maximum		10.00	
		Range		7.00	
		Interquartile Range		3.75	
		Skewness		-.489	.374
		Kurtosis		-.929	.733
	White Noise	Mean		7.1250	.34416
		95% Confidence Interval for Mean	Lower Bound	6.4231	
			Upper Bound	7.8269	
		5% Trimmed Mean		7.1389	
		Median		7.0000	
		Variance		3.790	
		Std. Deviation		1.94688	
		Minimum		4.00	
		Maximum		10.00	
		Range		6.00	
		Interquartile Range		3.75	
		Skewness		.121	.414
		Kurtosis		-1.324	.809

Figure 7

Descriptive Statistics of Individual Condition Scores

Mean Score Per Condition

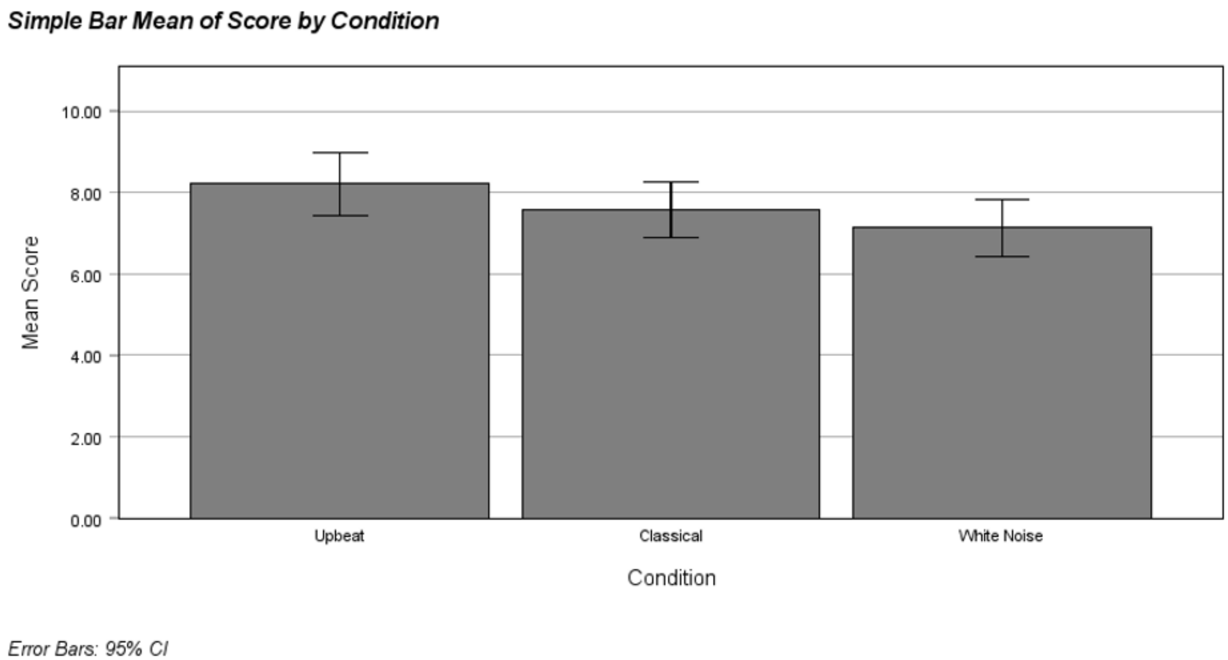

Figure 8

Bar Graph of Individual Condition Score Means (Includes 95% Confidence Intervals)

Appendix A

Debrief

Thank you for participating in this study. Before you leave, we would like to take a moment to explain the purpose of this survey. The primary objective of this study was to investigate the effect music has on mathematical test performance, with the incorporation of different genres. We assure you that your results will be kept completely anonymous. Once again, we appreciate that you gave us some of your time today to provide valuable data for our research.

Appendix B

Qualtrics Survey Math Test

The following ten basic arithmetic problems were included in the Qualtrics survey to assess participants' mathematical performance under various music conditions:

1. $9+8$
2. $32-18$
3. $57+16$
4. 5×9
5. $11-7$
6. $72\div 6$
7. 13×7
8. $89-27$
9. $17+8$
10. $56\div 8$

Appendix C

Music Files Information

The following table lists the music tracks used in the survey, along with the corresponding genre classifications assigned to each condition. All music used was non-copyright royalty-free files, downloaded from free-source websites.

Song Title	**Artist**	**Genre Condition**
Lights	Sakura Girl	Upbeat Condition
Undertow	Scott Buckley	Classical Condition
White Noise	Unknown	White Noise Condition

Table C1

Music tracks and their assigned genre conditions for the survey.

Appendix D

Manipulation Check

To confirm that participants heard and were affected by the musical conditions, we included a short manipulation check at the end of the survey. The following questions were asked:

1. *Did you hear any sound coming from the audio file?*

2. *What genre of music did you listen to while taking the test?*

3. *Do you feel like you performed better with the music?*