

The Influence of Music on Memorization Performance Of Mathematics Students

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ABSTRACT: Science has indicated that the left side of the brain performs tasks that are related to logic, such as in science and mathematics while the right performs tasks related to creativity and arts, including music which can affects the brain in many positive ways. Mathematics students tend to use the left brain more than the right brain and as a result, they may encounter difficulties in courses that are not related to mathematics which require reading and memorizing. Learning process and retention of information can be maximized with the simultaneous left and right brain activation. Music is believed to induce better memorization performance Therefore, in this study we introduce music during the memorization process to enhance the use of the right brain. A Complete Randomized Block Design experiment that has been done on mathematics students for testing the effect of music on memorizing performance shows that listening to music during memorizing improve the memorization performance. Furthermore, there is a difference in effectiveness in memorization performance using different types of music. Classical music has been found to be the best music to improve memorization performance. In conclusion, music can be considered as a tool by educators, parents and students to improve learning process.

Keywords: *music, memorization performance, mathematics student, complete randomized block design*

INTRODUCTION

Music is known to affect the brain in numerous ways. Listening to music in restaurants while dining can create the romantic mood and in shopping mall, it can create the relaxing mood while shopping. Besides that, music is also a source of entertainment. People love to spend their time listening to music in sick and in health. Music can improve health and reduce stress¹. Those having high blood pressure can lower their blood pressure by listening to music in the morning and evening². Patients with unilateral neglect after stroke can improve their visual attention by listening to classical music³. Music has become a tool for overcoming stress, improving health, increasing work productivity and helping brain development⁴.

Physical and work performance also can be affected by music. Many athletes around the world preferred listening to music because it can not only reduce their tension before the game started, but also make them perform better⁵. A positive effect has been observed on the performance of the athletes running 400 meter

¹ Collingwood, Jane. *The Power of Music To Reduce Stress*. 2015. <http://psychcentral.com/lib/the-power-of-music-to-reduce-stress/2/> (accessed April 29, 2016).

² Teng, X., Wong, M., & Zhang, Y. The effect of music on hypertensive patients. *Conf Proc IEEE Eng Med Biol Soc*. 2007.

³ Tsai, P. L., M. C. Chen, Y. T. Huang, K. C. Lin, K. L. Chen, and Y. W. Hsu. "Listening to classical music ameliorates unilateral neglect after stroke." *American Journal of Occupational Therapy* 67, no. 3 (2013): 328-335.

⁴ Alban, Deane. *Be Brain Fit*. 2014. <http://bebrainfit.com/music-affects-brain/> (accessed April 17, 2016).

⁵ Pottraz, Suzzane. *Music: How to effectively use it before, during, and after activity*. 2013. <http://believeperform.com/performance/music-how-to-effectively-use-it-before-during-and-after-activity/> (accessed April 29, 2016).

sprint with the use of synchronous music⁶. Music can improve our body movement and coordination where it also reduce our muscle tension since our movement are influenced by the rhythm and melody of the music⁷. Productivity at workplace are also affected by music where workers productivity has been found to improve when music was played at the workplace⁸. Therefore, workers productivity can be increased by assigning background music at workplace.

In education, music has been proven to influence academic performance. Gallup Poll says that 85% of Americans say that those participating in a school music program achieve better grade⁹. A musician playing music on a daily basis can bring great impact to their brain structure. Furthermore, data collected by the Harris Poll Company indicated students that join music program at school tend to achieve a larger income and higher level of education compare to those not joining the music program¹⁰. There is significant difference between musician brains and non-musician brains in their functionality¹¹. A study has been done to observe how music affected the brain development and how the brain of a musician is better than the brain of a non-musician¹². A recent finding has found that playing an instrumental music will give positive impact on the brain even if the playing was done casually¹³.

There is also an effect called "Mozart Effect" which indicates that listening to classical music especially Mozart enhances performance on cognitive tests¹⁴. Moreover, a recent study has found that listening to any personally preferred songs have positive effects on cognitive performance¹⁵. It has also been said that when rock or classical music was used as background music, there was a higher ability to recognize visual image, letters and numbers faster¹⁶.

Listening to music helps improve memory performance. It has been shown that certain types of music can be useful tools for recalling memories¹⁷. Learning process and retention of information can be maximized

⁶ Lesiuk, Teresa. "The effect of music listening on work performance." *Psychology of Music* 33, no. 2 (2005): 173-191.

⁷ Rosenkranz, K., A. Williamon, and J. C. Rothwell. "Motorcortical excitability and synaptic plasticity is enhanced in professional musicians." *Journal of Neuroscience* 27, no. 19 (2007): 5200-5206.

⁸ Lesiuk, Teresa. "The effect of music listening on work performance." *Psychology of Music* 33, no. 2 (2005): 173-191.

⁹ Lyons, Linda. *Americans Want Music Students to Play On*. May 20, 2003. <http://www.gallup.com/poll/8434/americans-want-music-students-play.aspx> (accessed April 20, 2016).

¹⁰ Gosik, Ashley. *Poll: Music education, achievement likely linked*. November 13, 2007. http://articles.orlandosentinel.com/2007-11-13/news/music13_1_music-education-music-program-harris-poll (accessed April 29, 2016).

¹¹ Hyde, Krista L, et al. "The effects of musical training on structural brain development." *Annals of the New York Academy of Sciences* 1169, no. 1 (2009): 182-186.

¹² Schäfer, Thomas, Peter Sedlmeier, Christine Städtler, and David Huron. "The psychological functions of music listening." *Frontiers in Psychology* 4 (2013).

¹³ Wipf, Briana. *Research shows significant changes to brains of musicians*. 2016. <http://www.greatfalltribune.com/story/life/health-and-fitness/2015/05/18/research-shows-significant-changes-brains-musicians/27526723/> (accessed April 20, 2016).

¹⁴ Maas, Sarah Elizabeth. "The Effect of Background Music on Math Test Performance of High School Students." Doctoral dissertation, 2013.

¹⁵ Jausovec, Norbert. *How Music Affects Us and Promotes Health*. February 18, 2016. <http://www.emedexpert.com/tips/music.shtml> (accessed April 20, 2016).

¹⁶ Bharadwaj, A. K., and P. R Bharadwaj. "A Study on the effect of Instrumental Music on Emotional Competency." *International Journal of Yoga and Allied Sciences* 2, no. 1 (2013): 39-43.

¹⁷ Jausovec, Norbert. *How Music Affects Us and Promotes Health*. February 18, 2016. <http://www.emedexpert.com/tips/music.shtml> (accessed April 20, 2016).

with the simultaneous left and right brain activation. The brain functions better when the left brain processes cognitive information and the right brain processes the music at the same time.

Many parts of the brain including the auditory and motor are activated while listening to music¹⁸. Having such a great amount of activated brain parts helps to improve reading and literacy skills¹⁹. It can also help to enhance the spatial reasoning skills and mathematical abilities²⁰. Spatial reasoning skill is a skill to understand how things related and associated, which is required in careers such as architecture, engineering and mathematics. The following Figure 1 indicates the parts of brain that react when playing or listening to music.

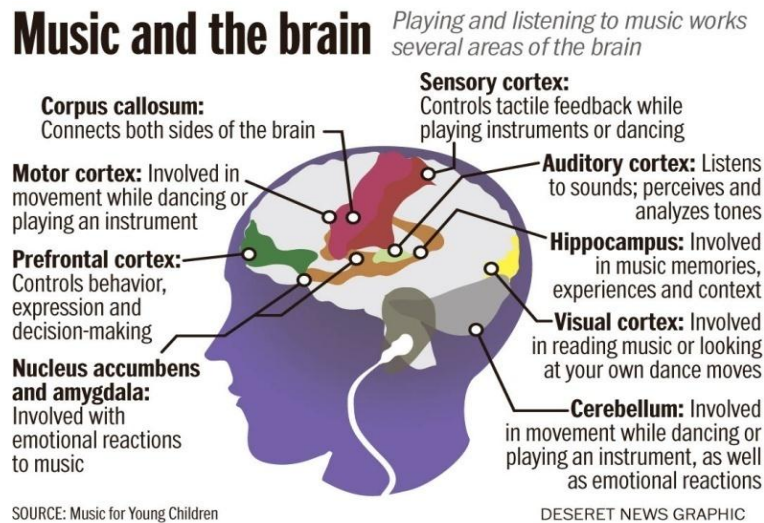


Figure 1: Music and the brain

The left brain is utilized in verbal and analytical activity such as comprehending facts, processing language, solving mathematics and computing while the right brain is utilized in non-verbal and intuitive activity such as developing creativity, creating arts, processing feelings and having imagination²¹.

PROBLEM STATEMENT

In general, students taking analytical courses like statistics and mathematics actively use their left brain while students in non-verbal courses like music, film and arts actively used the right brain. Since students in academic programmes that are analytical in nature such as mathematics and statistics might actively use their left brain even for the non-analytical courses or reading subjects that require verbal activity involving memorization, they may need to acquire new tools to assist them in scoring good grades for such courses. By having background music, our left and right brains are reacting together therefore causing the

¹⁸ Zatorre, R. J., J. L. Chen, and V. B. Penhune. "When the brain plays music: auditory-motor interactions in music perception and production." *Nature reviews. Neuroscience* 8, no. 7 (2007): 547.

¹⁹ Besson, M., D. Schön, Moreno, S., A. Santos, and C. Magne. "Influence of musical expertise and musical training on pitch processing in music and language." *Restorative Neurology and Neuroscience* 25, no. 3-4 (2007): 399-410.

²⁰ Jausovec, N, K Jausovec, and Gerlic. *The influence of Mozart's music on brain activity in the process of learning*. Dec 2006. <http://www.ncbi.nlm.nih.gov/pubmed/17029951> (accessed April 21, 2016).

²¹ Mclendon, Kelly. *Funderstanding*. 2012. <http://www.funderstanding.com/brain/left-brain-learning/> (accessed April 30, 2016).

process of retaining and recalling information to be more effective. Therefore, it has also been suggested to integrate music and mathematics education²². Many studies have been done to show the relationship between music and mathematics achievement²³. Numerous studies have also looked into effect of background music on memorization²⁴. In addition, there are studies that have focused on types of music in enhancement of memorization²⁵ and mathematics learning²⁶.

However, students with mathematical minds could be having a hard time at memorizing which is necessary for the reading type of courses. Therefore, this study aims to examine the effect of music on the performance of mathematics students in word memorization. An experiment has been conducted to check the claim by testing whether memorizing process of students in academic programmes that are analytical in nature is affected by music. Another objective of this study is to determine the best music to use during memorization. The participants were students of Universiti Utara Malaysia which is an academic institution in the northern part of Malaysia. The study is focused on students in the School of Quantitative Sciences where there are three types of academic programmes offered, namely industrial statistics, decision science and business mathematics.

METHODOLOGY

This research was an experimental study in investigating the effectiveness of music to the memorizing processes. A complete randomized block design experiment has been done on mathematics students from the School of Quantitative Sciences, Universiti Utara Malaysia. The set of data consist of three variables: gender of the participants, the type of music and the scores obtained from the experiment. The type of music is considered as treatment while gender is considered as block and their levels are as indicated in Table 1. Other factors that might influence their scores such as age and health condition are controlled.

²² Brock, D., and D. Lambeth. "The Effects of Music on Basic Mathematics Fact Fluency for Third Grade Students." *Cumhuriyet International Journal of Education* 2, no. 2. 2013. 43-60. Nesimovića, S., and M. Zećoa. "The Correlation Between Mathematics and Music—Practice With the Students of the Pedagogical Faculty in Sarajevo." *Sociology Study* 5, no. 10. 2015. 800-808. Viladot, L., et al. "The integration of music and mathematics education in Catalonia and England: perspectives on theory and practice." *Music Education Research*, 2017. 1-12.

²³ Kesan, C., Z. Ozkalkan, H. Iric, and D. Kaya. "The Effect of Music on the Test Scores of the Students in Limits and Derivatives Subject in the Mathematics Exams Done with Music." *International Online Journal of Primary Education* 1, no. 1. 2012. 1-7. Maas, Sarah Elizabeth. "The Effect of Background Music on Math Test Performance of High School Students." Doctoral dissertation, 2013. Pinnock, G. "Using Live Reggae Instrumental Acoustic Music to Influence Students' Mathematics Test Scores." *Journal of Mathematics Education* 8, no. 2. 2015. 115-125.

²⁴ Woloszyn, M. R., & Ewert, L. "Memory for facial expression is influenced by the background music playing during study." *Advances in Cognitive Psychology* 8, no. 3. 2012. 226-233. Ferreri, L., J. J. Aucouturier, M. Muthalib, E. Bigand, and A. Bugaiska. "Music improves verbal memory encoding while decreasing prefrontal cortex activity: an fNIRS study." *Frontiers in Human Neuroscience* 7. 2013. Art.779. Bottiroli, S., A. Rosi, R. Russo, T. Vecchi, and E. Cavallini. "The cognitive effects of listening to background music on older adults: processing speed improves with upbeat music, while memory seems to benefit from both upbeat and downbeat music." *Frontiers in Aging Neuroscience* 6. 2014. 1-7. Keramati, A., H. Irvani, and V. Ghahraman. "Short term memory and the role of background music." *International Journal of Language Learning and Applied Linguistics World* 5, no. 4. 2014. 161-167. Proverbio, A. M., et al. "The effect of background music on episodic memory and autonomic responses: listening to emotionally touching music enhances facial memory capacity." *Scientific reports* 5. 2015. 17237.

²⁵ Su, Q., and F. Wang. "Study the effect of background music on cognitive memory." *Applied Mechanics and Materials* 37. 2010. 1368-1371.

²⁶ Kesan, C., Z. Ozkalkan, H. Iric, and D. Kaya. "The Effect of Music on the Test Scores of the Students in Limits and Derivatives Subject in the Mathematics Exams Done with Music." *International Online Journal of Primary Education* 1, no. 1. 2012. 1-7

Table 1: Treatments and Blocks

| FACTOR | LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 |
|--------------------------------|----------|-----------|----------------------|------------------|
| Types Of Music: (treatment) | No music | Classical | Rock Alternatives | Electro House |
| Gender: (Block) | Male | Female | | |

The tools and instruments used in the experiment are as follows:

1. Table and Chair – A comfortable place for the participants to memorize and recall the words.
2. Word list – A paper with a list of 40 English words.
3. Sheets of paper – For the participants to write down the words that they recall.
4. Laptop – To play the assigned music
5. Speaker – To amplify the sound of the music
6. Stopwatch – To set the time for the participants to memorize the word list.

Each participant is given three minutes to memorize all the 40 English words in the word list. One type of music is played while the participants memorized the given words. After the three minutes were up, the list word were taken back from them and a piece of blank paper is then given to each participant to write down the words that they can recall. The score achieved by each participant is determined by the number of correct words written on the paper.

All the assigned background music types used in this experiment are non-vocal instrumental music since it has been stated that the sound of the human vocal can distract the memorizing process (Maas 2013). The types of music used in this experiment are classical, rock alternatives and electro house. The experiment has also used no background music to test the difference of scores when memorizing with music and without music.

The model obtained from the Complete Randomized Block Design (CRBD) can be written as

$$y_{ij} = \mu + T_i + \beta_j + \varepsilon_{ij}$$

where :

- μ is a constant (overall mean)
- T_i is the music effect of type i ($i = 1, 2, 3, 4$)
- β_j is the gender effect (block) of type j ($j = 1, 2$)
- ε_{ij} is the random error for the i -th treatment in the j -th block.

RESULTS & DISCUSSION

Profile analysis has been used to roughly see the differences of scores achieved using different types of music assigned within the gender block.

Table 1: Scores of Participants

| Gender(block) | Types Of Music (treatment) | | | |
|---------------|----------------------------|-----------|-------------------|---------------|
| | No music | Classical | Rock Alternatives | Electro House |
| Male | 10 | 16 | 13 | 13 |
| Female | 11 | 15 | 12 | 12 |

From Table 2 and Figure 2, it can be observed that for both gender, listening to the classical music yields the highest score, with 16 for male and 15 for female. In addition, when there is no music in the background, the score achieved by both gender is the lowest. Then, the scores achieved by males were higher than females when there was music assigned but the females score higher than males when there was no music assigned. Therefore, both males and females tend to score better in their cognitive test compared to when there is no music assigned. Then, we can roughly say that listening to music while memorizing is better than no music and the classical music is the best music to use.

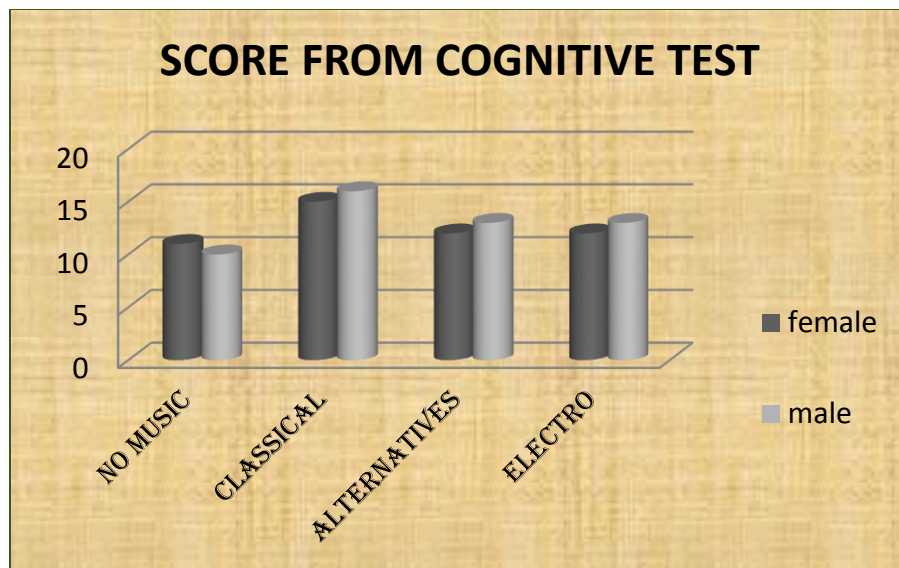


Figure 2: Comparison of scores between gender of participants and among types of music

A more precise analysis is then carried out where Table 3 shows results of the test that precisely indicate the significance of the difference of scores achieved using different types of music assigned. In the table, the *p*-value for the type of music is 0.022 which is smaller than 0.05. Therefore, we can conclude that there are significant differences among the treatments. Since there are differences between the treatments, we can conclude that when difference types of music were used for memorizing, the scores are different. Although we can conclude that music has an effect on memorizing process, however, from this particular test we are not able to determine whether the effect is positive or negative.

Table 3: Tests of Between-Subjects Effects

| Source | F | p-value |
|------------|---------|---------|
| Model | 530.600 | .000 |
| Music_Type | 17.000 | .022 |
| Gender | 1.000 | .391 |

Therefore, further analysis has been done using multiple comparison test to see whether listening to music during memorizing process gives positive or negative effect. This analysis focuses to achieve our second objective which is to find the best type or types of music to use during memorizing process.

Table 4: Multiple comparison test

| (I) Music_Type | (J) Music_Type | Mean Difference | Sig. |
|----------------|----------------|-----------------|-------|
| No music | Classical | -12.5000 | .022 |
| | Alternatives | -5.0000 | .221 |
| | Electro House | -5.0000 | .221 |
| Classical | No music | 12.5000 | .022 |
| | Alternatives | 7.5000 | .088 |
| | Electro House | 7.5000 | .088 |
| Alternatives | Electro House | .0000 | 1.000 |

As we can see from the multiple comparisons test result shown in Table 4, the mean difference were all negative values. Even though the values were only significant when compared with classical music, we can say that the mean score of students who used music to memorize is higher than the mean score without music. Therefore we can say that having background music has given positive effect on memorizing process. We set the null and alternative hypotheses as follows:

$$H_0: \mu_{classical} \leq \mu_{no\ music}$$

$$H_1: \mu_{classical} > \mu_{no\ music}$$

Referring to the last column in Table 4, the significant value obtained when comparing classical music and no music is 0.022 which is smaller than 0.05. Therefore we can reject the null hypothesis and claim with 95% level of confidence that classical music has produced better score than no music. Since there are no other types of music that has given significant results, therefore we have achieved our second objective where classical music has been found to be the best background music to use when memorizing.

CONCLUSION

An experiment with the implementation of Complete Randomized Block Design has been done to observe the effect of different types of non-vocal instrumental music towards score of word memorization of mathematics and statistics students. The results have indicated that listening to music does indeed give a significant positive effect during memorizing process and the best music to be used is the classical music. Therefore, having background music can be considered as an effective tool by educators, parents and students to improve learning in general and memorization in particular. This study only considers three types of music. Future research may involve comparison with other types of music including local community non-vocal instrumental music

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