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Samantha Domingo
Nova Southeastern University

Running head: THE EFFECTS OF CLASSICAL VERSUS ELECTRONIC MUSIC

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Nova Southeastern University

Abstract

Research about the possible positive effects of classical music on learning and recall has been quite extensive in the past few years; this phenomenon is known as the Mozart effect. The present study attempted to evaluate the theory that listening to classical music enhances the learning and subsequent recall of new information. Twenty-four undergraduate students participated in this study. In a 2x2 ANOVA design, all participants were assigned to read a short passage while listening to one of four types of music: classical music at either high or low volume, or electronic music at either high or low volume. The classical music had more of a calm, peaceful quality whereas the electronic music was more of a fast-paced, arousing nature. Subsequently, participants filled out a questionnaire designed to test their recall for the information in the reading passage. No significant differences in recall were found between groups. However, it is suggested that future studies with more participants and more sophisticated research designs be employed before rejecting the Mozart effect.

The Effects of Classical versus Electronic Music on Learning and Recall

In the past few years, interest on the effects of music on learning and memory has increased. There is extensive research on the potential beneficial role music may play for the improvement of some basic cognitive functions. More specifically, listening to classical music while performing cognitive tasks—such as learning new information—has been shown to improve spatiotemporal function (Crncec, Wilson & Prior, 2006). This phenomenon, more commonly known as the *Mozart effect* (Chikahisa et al., 2006), has been the subject of great controversy among the behavioral brain research community, because of the inconsistency of results across laboratories and lack of reliability (De Groot, 2006). While there have been positive results that support the theory, the success of these studies has been highly questioned. Currently, there are two models that attempt to explain the Mozart effect: the trion model and the arousal-mood model (Crncec et al., 2006).

The trion model is a mathematical model that attributes improvement on spatiotemporal functions after exposure to a structurally complex musical composition, such as those by Mozart (Crncec et al., 2006). According to Crncec et al., "Mozart's music is structured according to complex, spatial and temporal patterns, and exposure to Mozart primes the brain for spatiotemporal tasks" (p. 306). In other words, this sort of music stimulates a part of the brain that is associated with neurological functions such as memory (Crncec et al., 2006).

Exposure to music has been linked to neurogenesis in the hippocampus of laboratory rats (Kim et al., 2006). Regeneration of neurons, in turn, has been related to the formation of certain kinds of memory. Kim et al., 2006 investigated this effect with the use of laboratory rats. There were three groups of pregnant rats: a group exposed to noise (not clearly defined by the authors) for one hour a day with the use of a 95 Db supersonic machine, a group exposed to 65 Db of music for one hour a day, and the control group, which was left undisturbed. When the pups were born, they were tested on spatial memory and neurogenesis in the hippocampus. The results indicated that those rats exposed to "comfortable music" during pregnancy showed more neuron regeneration in the hippocampus and enhanced learning ability. On the other hand, those pups that had been exposed to noise during pregnancy showed decreased neurogenesis in the hippocampus and impaired spatial learning ability. These results indicate that exposure to music may have beneficial cognitive effects, whereas exposure to other types of noise may have a deleterious effect on cognitive functioning.

In a later study by Chikahisa et al. (2006), rats that were exposed to either noise or classical music during their perinatal period were tested as adults for learning behaviors. In addition, their levels of brain-derived neurotrophic factor (BDNF) and its receptor, tyrosine kinase receptor B (TrkB) were measured and compared (Chikahisa et al., 2006). BDNF and TrkB have been shown to be of importance in synaptic plasticity, which aids in the regeneration of neurons and as a result, improves spatial memory and learning (Chikahisa et al., 2006). Their results indicated that those rats that had been exposed to music during pregnancy had higher levels of BDNF and TrkB in the cortex than those rats that had been exposed to noise (Chikahisa et al., 2006). In other words, rats that had been exposed to music showed a significant improvement in memory and learning capabilities when performing some tasks involving a maze (Chikahisa et al., 2006).

On the other hand, some studies have not found any support for the Mozart effect. A study by Hallam (2000) sought to investigate the Mozart effect in children. The sample consisted of 8,120 children of ages 10-11 recruited from 150 schools. First, the children were exposed to either classical music composed by Mozart, popular music (by various artists, not mentioned in the study), or a scientific discussion. Then they were given tests on spatial reasoning. Hallam's analysis showed no significant differences in the results of the three groups. However, this study did not include a control condition of silence, so the results may be attributed to a general effect of listening to auditory material (Crncec et al., 2006). Furthermore, there was no variable that would serve as a baseline to compare each auditory condition. In addition, Hallam focused on testing children's spatial reasoning; the Mozart effect may not affect spatial reasoning but may still affect recall (which is the focus of the present research).

Does symphonic classical music, enhance learning and subsequent recall for information, as proponents of the Mozart effect maintain? The answer to this question could potentially benefit school systems, people attempting to learn a new language, people in the workforce who need to learn and recall large amounts of new information, and people who suffer from neurodegenerative conditions such as Alzheimer's. In the present research, the effect of listening to classical versus modern electronic music on recall was tested. Classical music is a broad term that refers to the European musical movement of the 18th century. Electronic music refers to any kind of synthesized sound that is produced by the use of electronic devices. For this study, the two musical pieces had a very distinct sound. The classical piece had a slower pace, while the electronic piece had a faster pace. In addition, both low and high volume levels of both types of music were compared. Higher volume may have the result of being more distracting than lower volume. Thus, it was predicted that listening to classical music during the learning process would result in greater subsequent recall than listening to modern electronic music. Finally, it was predicted that listening to low-volume music during the learning process would result in greater subsequent recall than listening to high-volume music.

Method

Participants

Participants consisted of 24 undergraduate students at Nova Southeastern University. There were no restrictions on participants' gender or ethnicity. All participants were at least 18 years old. No special or vulnerable populations were sought for the study.

Participants were given a small amount of extra credit in their psychology course in exchange for their participation. Students in two Psychological Research Methods classes and one Social Psychology class were given the opportunity to participate, unless they were under the age of 18. Students who did not meet the age requirement, as well as students who did not wish to participate, were given the opportunity to earn extra credit by writing a two-page report on music and cognition; thus, all students had an equal opportunity to receive extra credit.

Design and Procedure

Participants were randomly assigned to one of these four conditions: electronic music at either high or low volume; classical music at either high or low volume. There were six participants in each condition. They were asked to read a short informational passage (refer to Appendix A) while being exposed to music for three minutes. The reading material, taken from an educational website designed for teachers (www.abcteach.com) was college-level so it could be easily understood by all the participants. Once they were finished, they were asked to answer a questionnaire regarding the information they read.

The study was conducted in a classroom on the campus of Nova Southeastern University.

Participants completed the exercise individually. After participants signed their consent forms, they were assigned a number in order to ensure confidentiality. All participants were randomly assigned to any of these four conditions: classical music at either high or low volume, or electronic music at either high or low volume.

Participants in the four conditions were asked to read a short passage while listening to the assigned music for three minutes. Participants in the "classical music" condition listened to Beethoven's 3rd Movement, "Adagio Molto e Cantabile." Participants in the "modern electronic music" condition listened to a piece by D.J Tiesto titled "Traffic," which contains a moderate to fast tempo. The music was played with the use of a fifth generation iPod. For the purpose of this study, high volume is defined as the setting of approximately ¾ of the volume bar of the iPod. Low volume refers to the setting of ¼ of the volume bar of the iPod.

Participants were given exactly three minutes to read the passage. Immediately after reading the passage, participants were given exactly five minutes to answer the questionnaire. A copy of the reading passage and questionnaire are attached (see Appendix A). The questionnaire is composed of 10 items; 7 short answer and 3 multiple choice. The short answer questions give the participant the opportunity to write down the first thing that comes to their mind; the multiple choice questions give the participant more of a chance to pick the correct option from a variety of options, possibly allowing them to remember the information that is being asked. A combination of both types of questions better assesses the learning process by addressing different learning types; some people are better at recognizing correct information—hence the multiple- choice questions—while some people are better at simply recalling information, in which case the short answer questions are more appropriate.

After each participant was given five minutes to fill out the questionnaire, the experimenter collected the questionnaire and debriefed the participant. All participants were thanked for their time. Their names were recorded in order to let their professor know that they should receive extra credit; however, their individual results were not matched with their names, in order to preserve anonymity.

Results

A 2 (type of music) X 2 (volume level) between- participants ANOVA was run. Contrary to the hypotheses, neither type of music nor volume level significantly affected the level of recall.

There was no main effect of type of music on recall, F (1, 20) = 1.49, p = .24. However, the mean for classical music (M = 58.33) was non-significantly higher than the mean for electronic music (M = 48.33).

In addition, there was no main effect of volume level on recall, F (1, 20) = .37, p = .55. The mean level of recall in the low volume conditions was 50.83, and the mean level of recall in the high volume conditions was 55.83.

Finally, there was no significant interaction between type of music and volume level, F (1, 20) = .37, p = .55.

Discussion

In the present research, neither type nor volume level of music affected the learning and subsequent recall of new information. However, it should be noted that this sample size was significantly small for a between-participants analysis with two independent variables. In a larger sample, the difference between the classical music and electronic music conditions may be statistically significant.

One reason for the lack of statistically significant results could simply be attributed to differences in learning styles. Perhaps classical music enhances learning and recall only for some people. Furthermore, given that the participants were mainly Psychology students, it is difficult to make assumptions about other populations. Future research would benefit from the attempt to determine precisely which personality variables and cognitive styles enhance or diminish the Mozart effect.

Some of the research supporting the Mozart effect has been done on rats, such as one by Chikahisa et al. (2006), in which pregnant rats were exposed to either white noise or a piece by Mozart during the gestation period. Once the pups were mature enough, they were tested on a maze for cognitive abilities. Those rats that had been exposed to music by Mozart during the perinatal period were less prone to error than rats exposed to white noise (Chikahisa et al., 2006). However, humans (unlike rats, presumably) have emotional ties to different types of music, which may in turn affect learning and recall. Future researchers may wish to investigate the effects of liked versus disliked music on learning and recall.

Furthermore, there is another explanatory model of the Mozart effect, known as the arousal-mood model, which attributes enhanced recall simply to the participants' enjoyment of music. Listening to pleasant sounds has been shown to affect mood positively as well as to produce a state of arousal, which, in turn, can influence cognition, especially spatiotemporal tasks (Crncec et al., 2006). Music has been used in pedagogical settings in order to improve learning and to set a stimulating learning environment (Kouri & Winn, 2006). According to

Kouri and Winn (2006), “a number of studies have supported the reinforcement and motivational value of music as well as its usefulness as an attention-focusing device or behavior modification tool” (p. 293).

There are many possible practical applications that can be obtained by further investigating this subject; aside from pedagogical purposes, the Mozart effect can certainly benefit those in the workforce, those suffering from neurodegenerative diseases, and those learning a new language, for instance. In addition, according to Campbell (2000), the Mozart effect has also been shown to be beneficial to children’s development and creativity. Campbell (2000) believes that exposing children to classical music at a very young age, even before they are *born* can help increase children’s potential, making them more prone to be faster learners and helping them unleash their creative talents (Campbell, 2000).

In light of the contradictory results from studies on the Mozart effect, further investigation is highly encouraged given the possible fruitful implications for learning and recall.

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Author Note

Samantha Domingo, Division of Social and Behavioral Sciences, Farquhar College of Arts and Sciences, Nova Southeastern University.

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Correspondence concerning this article should be sent via electronic mail to dsamanth@nova.edu.

Appendix A

Reading Passage and Questionnaire

Reading Passage

Instructions: *Please read the following passage and be prepared to answer questions regarding the information after you read.*

Alexander the Great stood with his army on the western shore of the Tigris River. He and his men had marched north from Tyre, crossing acres and acres of blackened land. Darius III had had his "Immortals" burn to the ground the long wheat grass that had been growing there. He had hoped to slow the advance of Alexander and his mighty fighting force. Darius' strategy had done little to delay the progress of the G reek forces. They prepared now to ford the Tigris, and to continue onward toward the village of Mosul. They knew that Darius III and the Persian warriors were camped nearby on the plain of Gaugamela. They remained unaware of Darius' newest tactic. When Alexander and his men reached the plain of Gaugamela, they found that the ground had been made level. The Persian chariots stood in formation, ready to attack across that flat surface. Darius expected his scythed chariots to propel themselves forcefully into the Greek forces, with their curved blades ripping at the flesh of both horses and men. The chariots began their rapid drive toward the army of Alexander the Great. The Greek general, having made a quick assessment of the situation, ordered the ranks of the Greek fighters to split apart. This maneuver left the Persians moving forward, without having anyone to mow down. Because they traveled at great speed, the Persians could not get turned around. Caught between enemy lines, many Persian chariot drivers fell victim to the spears and arrows of their Greek opponents. Still, Darius was not ready to surrender. He spotted places where his men could outflank the Greeks, sneaking around behind the enemy ranks. Some enemy units met the fate that Darius had intended, that of being run over by the Persian chariots. None of this, however, seemed to faze Alexander the Great. The Greek general ordered the Companions, the cavalry, to form a wedge. The point of the wedge charged directly at Darius. The Persian King fled, leading to a collapse of whatever resistance he had managed to muster. Alexander the Great again emerged as the victor. Alexander's first impulse was to direct his men on a chase after the fleeing Darius. He chose, instead, to go south to Babylon, where he allowed his men to have one month of rest. From there Alexander headed his army east, toward the treasures that lay in central Persia.

Questionnaire: *Please answer the following short-answer questions. If you do not remember the information, please specify.*

1. Where did Alexander the Great and Darius III have their second meeting? ____________
____

2. What pointed object did the flanks of the Greek Companions resemble when they charged at the Persians? ____
____

3. Who won the battle on the plain of Gaugamela? ___________________________________
____

4. Darius III hoped to beat Alexander by using scythed ______________________________.

5. After defeating Darius III, Alexander the Great took his men to Babylon, where they rested for their journey to central ____.

6. In order to have their second meeting with Darius III, Alexander and his men crossed the _________River.

7. Did Darius give up when he found his chariots surrounded? _______________________
____

Multiple Choice: *Please circle your choice of answer*

1. Alexander the Great marched northeast from Tyre, taking his men to:
   a) the Euphrates River
   b) the Tigris River
   c) central Persia
   d) a charred plain

2. Which of the following tactics did Darius III not use?
   a) burning wheat grass above Tyre
   b) having scythed chariots
   c) outflanking the Greeks on the Gaugamela plain
   d) none of the above

3. Which of the following helped to insure the victory of Alexander the Great?
   a) having scythed chariots
   b) having the Greek warriors part ranks
   c) formation of a wedge
   d) b and c