Abstract

The present study seeks to investigate the “Mozart effect” on spatial reasoning ability. The study specifically searched for possible differences among effects brought on by soft relaxing music, by Mozart sonata K-448 and by silent condition in spatial reasoning ability. It was hypothesized that performance will be better in sonata K-448 condition than silent condition and soft relaxing music condition. The experiment was divided into three conditions: silent condition, Mozart’s piano sonata no K448 music condition and soft relaxing music condition. 60 participants were participated in the experiment. There was logic and cognitive reasoning task to measure in each music condition. A within subject design was followed to perform these three conditions. Paired sample t-test and independent sample t-test found that the performance was better in sonata K-448 condition than silent condition and soft relaxing music condition.

The “Mozart Effect” on Spatial Reasoning Ability

Music affects us all. We sing with it and dance to it. We accompany our most important rituals with music. We sing hymns to our Gods and pen anthems for our nations. There is no culture in the history of mankind that has not had music. Science has always tried to explain music, to tell us why and how it affects us so.

The Mozart effect can refer to a set of research results indicating that listening to Mozart's sonata K-448 may increase a short-term improvement on the performance of certain kinds of mental tasks known as "spatial-temporal reasoning”. (Rauscher, Shaw, & Ky, 1995). Listening to Mozart enhances spatial temporal reasoning

Spatial reasoning is a category of reasoning skills that refers to the capacity to think about objects in three dimensions and to draw conclusions about those objects from limited information (APA, 2015).Spatial-temporal reasoning is required for higher brain functions relevant to chess, mathematics, and engineering. It is said that spatial ability is important in designers.

Spatial ability may be defined as the ability to generate, retain, retrieve and transform well-structured visual images. There are four common types of spatial abilities which include spatial perception, spatial visualization, mental folding and mental rotation. Spatial perception is defined as the ability to perceive spatial relationships in respect to the orientation of one's body despite distracting information. Mental rotation on the other hand is the mental ability to manipulate and rotate 2D or 3D objects in space quickly and accurately. (Rauscher, Shaw, & Ky, 1995)

Lastly, spatial visualization is characterized as complicated multi-step manipulations of spatially presented information .These three abilities are mediated and supported by a fourth spatial cognitive factor known as spatial working memory. Spatial working memory is the ability to temporarily store a certain amount of visual-spatial memories under attentional control in order to complete a task.

The cognitive ability mediates individual differences in the capacity for higher level spatial abilities such as mental rotation. (Spatial ability" (PDF). www.jhu.edu. Johns Hopkins University.) Mental rotation is the ability to mentally represent and rotate 2D and 3D objects in space quickly and accurately, while the object's features remain unchanged.(Donnon, Tyrone; DesCôteaux, Jean-Gaston; Violato, Claudio .2005-10-01).

Sonata, a type of musical composition , usually for a solo instrument or a small instrumental ensemble, that typically consists of two to four movements, or sections, each in a related key but with a unique musical character. (Bernard Jacobson Artistic Adviser, North Netherlands Orchestra.) Ludwig Van Beethoven’s Moonlight sonata, Appasionata, Debussy’s Clair de Lune, Mozart’s The Sonata for Two Pianos in D major, K. 448 are most famous sonatas.

The Sonata for Two Pianos in D major, K. 448, is a work composed by Wolfgang Amadeus Mozart in 1781. This is one of his few compositions written for two pianos. It has three movements,(Zaslaw, Neil, The Complete Mozart: a Guide to the Musical Works, p. 301)

1. Allegro con spirito
2. Andante in G major
3. Molto Allegro.

Mozart Effect and spatial reasoning ability

The term “Mozart Effect” first appeared in 1991, in a book by Dr. Alfred A. Tomatis titled “Pourquoi Mozart.” He advocated alternative medicine solutions for dyslexia, autism and other learning disorders. Originally called “The Tomatis Effect”, the phenomena was said to have been observed as Dr. Tomatis used music with his patients during therapy sessions. (Rauscher, Shaw,,& Ky, 1995)

This concept became popular with the publication of 3 psychologist Frances Rauscher's study “Music and Spatial Task Performance”. There, at the University of California Dr. *Rauscher*, Gordon Shaw, and Catherine Kyconducted an experiment, where they used three groups college age subjects for their study. One group listened to Mozart's sonata for pianos in D major for ten minutes. Another group listened to relaxation instructions designed to lower blood pressure for the same amount of time.

Finally, the third group sat in silence. Directly afterwards they were given one of three abstract/spatial reasoning tasks from a Stanford-Binet intelligence scale, a pattern analysis test, a multiple choice matrices test and a paper-folding and cutting test. The researchers found that the subjects who had listened to Mozart's music scored eight to nine points higher than the subjects who listened to the relaxation instructions or the silence.

After that, Kerkin, Bates, and Mangan (1994) replicated these findings, but they failed to replicate the findings of Rauscher et al., they used of Raven’s Advanced Progressive Matrices. (Rauscher et al., 1993, 1995) Then Kristin M. Nantais and E. Glenn Schellenberg conducted an experiment. There they replicated and extended the basic findings of Rauscher et al. (1993, 1995). In their experiment’s, half of the participants listened to Mozart during the music

condition; the other half listened to Schubert and in another condition participants were to satin silence. The result showed that both groups, who are listened to Mozart and Schubert, their spatial temporal ability is higher than the group who sat in silent condition. They claimed that, although both pieces of music are relatively “easy listening” examples from the common practice period, their finding made it clear that the Mozart effect has nothing to do with Mozart in particular. Moreover, it seems likely that the effect would generalize to a wide variety of enjoyable pieces of music composed in the Classical (i.e., late 1700s; e.g., Mozart, Haydn) or Romantic (i.e., early 1800s; e.g., Schubert, Liszt) styles. (Nantais, Schellenberg; Psychological Science; 1999)

Theoretical Rationale

Mozart Effect’ has led many questions on the effects of background music on cognitive processing ability. Numerous attempts to replicate the results led to mixed conclusions. For example, some researchers found improvement in on cognitive experiment after listening to Mozart, some researchers did not find any improvement on spatial reasoning ability .Some researchers found that there is no Mozart Effect, it is the effect of classical music.

There is no concrete conclusion on whether there is any Mozart effect on spatial reasoning ability or not. So the goal of this experiment is to find out a concrete conclusion, if there is any Mozart effect on spatial reasoning ability.

This finding will help to improve people who have lacking in spatial reasoning ability. It will work as a pilot study which target is to apply Mozart effect on those people who need to improve their spatial reasoning ability, so that their spatial ability will increase permanently.

Research Question

Whether there is any Mozart effect on spatial reasoning ability?

Objectives

1. To determine whether there is any difference on spatial reasoning task between silent condition and sonata K-448 condition.

2. To determine whether there is any difference on spatial reasoning task between soft relaxing music condition and sonata K-448 condition

Hypothesis

Performance will be better in sonata K-448 condition than silent condition and soft relaxing music condition.

Variables

IV: Music (Sonata for Two Pianos in D major, K. 448 and soft relaxing music*)*

DV: Spatial reasoning task

Method

Participants

The study was conducted with sixty undergraduate students. Who are physically and mentally sound with good hearing and visual ability. Participant’s age ranges from 20 to 25 years.

Materials

1. Music. The Sonata for Two Pianos in D major, K. 448, composed by Wolfgang Amadeus Mozart. As relaxing music, we are going to use Beautiful piano music (vol. 1) for studying and sleeping. This relaxing music is composed by Peder B. Helland, and it is most popular in internet as a relaxing music.

2. Raven's Progressive Matrices task book’s subset C and D, first published in 1938. The booklet comprises five sets

3. Noise proof headphones.

4. Paper pencil

5. Computer *Experimental Design*

It was a laboratory experiment and the design for the present experiment was within subject design. In the experiment, there were three different conditions: silent condition, Mozart’s piano sonata no K448 music condition and soft relaxing music condition.

Each participant was participant in three conditions and there had an one day gap before each conditions. In silent condition participant had to sit in silence in 10 minutes and then the Raven's Progressive Matrices subsetC,D will be present. After completing the task there hada daygap before the next condition. Then the same participant willlisten to the Mozart’s piano sonata no K448 for about 10 minutes in music condition, then Raven's Progressive Matrices subset C,D will be present to the participant. After completing the task there was an other one day gap before the next condition. Then the participant had to listen to soft-relaxing music about 10 minutes and the subset C and D of Raven’s Progressive Matrices task book will be present to them. (The Mozart Effect: An Artifact of Preference; Nantais, E. Schellenberg). No feedback will be provided. The conditions will be counterbalanced to control the order effect.

Procedure

The study was conducted in the laboratory of Department of Psychology, University of Dhaka. Participants were tested individually. Participants were given an information sheet (Appendix) about the summary of the experimental procedure at the beginning of the experiment. Participants also received a verbal description. Participants completed a standard consent form (Appendix) and a demographic and personal information questionnaire. The experiment was divided into three conditions: silent condition, Mozart’s piano sonata no K448 music condition and soft relaxing music condition. In each condition the participant had to complete Raven's Progressive Matrices task book’s subset C and D immediate after listening to the Mozart sonata K-448 or after listening to the soft relaxing music or after sat in silence for 10 minutes. In Mozart sonata condition participants were listening to the first movement of Mozart sonata K-448 for about ten minutes through a noise proof headphone, which means the Allegro con spirito. Immediately after that participants were given Raven's Progressive Matrices task

book’s subset C and D. In the next day the data was collected through silent condition. In this condition participants had to sat in silence and also had to wear a noise proof headphone to control the extraneous variables. After that participants were given Raven's Progressive Matrices task book’s subset C and D and they had to fill up the answer sheets. The day after the silent condition soft relaxing music took place. In this condition participants had to listen to Beautiful piano music (vol. 1) for about 10 minutes and after that they had to fill up the answer sheets of Raven’s Progressive Matrices task book’s subset C and D . Each time after collecting data they were thanked for their sincere cooperation. The data were collected within 22 days. Data entry and all necessary analysis were done using SPSS program (IBM SPSS 20) for windows package.

Results

In analyzing the data, descriptive statistics, paired sample t-test and independent sample t-test were used to test all the hypothesis.

Table 1

Descriptive statistics of average correct response of spatial reasoning ability in Mozart sonata K-448 and soft relaxing music condition

Variables	N	Min	Max	*M*	*SD*
Age	60	20	25	22.12	1.47
Education	60	1	2	1.12	.32
Socio-economic background	60	2	2	2.00	.00
silent condition	60	9.00	19.00	13.17	2.42
soft relaxing music condition	60	11.00	22.00	17.67	2.52
Mozart sonata K 448 condition	60	12.00	24.00	21.03	2.32

Descriptive statistics e.g., means and standard deviations of correct response of silent condition was 13.17 ad 2.42,the mean and standard deviations of Mozart sonata K-448 condition was 21.03 and 2.32 and in soft relaxing condition it is 17.67and 2.52. The total number of participants was 60.

We can see that the group means are statistically significantly different because the value in the "Sig. (2-tailed)" row is less than 0.05. Which means both conditions are significantly different from each condition.

Table 2

Paired Samples Tests for average Correct Responses of Soft relaxing Music Condition and Silent Condition

Variables	*M*	*SD*	*t*	Sig.(2-tailed)
Soft relaxing music condition	17.6667	2.52222	11.511	.000
Silent condition	13.1667	2.42282		

Table 3

Paired Samples Tests for average Correct Responses of Mozart Sonata K-448 Music Condition and Silent Condition

Variables	M	SD	t	Sig.(2-tailed)
Mozart Sonata Condition	21.0333	2.32136	18.206	.000
Silent Condition	13.1667	2.42282		

We can see that the group means are statistically significantly different because the value in the "Sig. (2-tailed)" row is less than 0.05. Which means both conditions are significantly different from each condition.

Table 4

Paired Samples Tests for average Correct Responses of Mozart Sonata K-448 Music Condition and Soft relaxing Music Condition

Variables	M	SD	t	Sig.(2-tailed)
Mozart Sonata Condition	21.0333	2.32136	8.526	.000
Soft relaxing music condition	17.6667	2.52222		

We can see that the group means are statistically significantly different because the value in the "Sig. (2-tailed)" row is less than 0.05. Which means both conditions are significantly different from each condition.

Table 6

Variables		*M*	*SD*	*t*	Sig. (2-tailed)
Soft relaxing music condition	Male	. 82314	.64824	-1.270	.209
	Female	.82314	.64716	-1.272	.208
Mozart Sonata Condition	Male	.26919	.60382	.446	.657
	female	.26919	.60268	.447	.657

An independent-sample t-test was conducted to compare mean difference of average correct response of soft-relaxing music condition and Mozart Sonata K-448 music condition by gender. Table 6 indicates that there is no significant difference in the mean correct response in soft-relaxing music condition between female and male ,Mozart sonata K-448 condition and male and female.

Discussion

The purpose of this study was to investigate the “Mozart effect” on spatial reasoning ability. The study specifically searched for possible differences among effects brought on by soft relaxing music, by Mozart sonata K-448 and by silent condition in spatial reasoning ability. It was hypothesized that Performance will be better in sonata K-448 condition than silent condition and soft relaxing music condition. The experiment was divided into three conditions: silent condition, Mozart’s piano sonata no K448 music condition and soft relaxing music condition. 60 participants were participated in the experiment. There was logic and reasoning cognitive task to measure in each music condition. A repeated measurement design was followed to perform these three conditions. Paired sample t-test and independent sample t-test found that the Performance was better in sonata K-448 condition than silent condition and soft relaxing music condition.

The design for the experiment was repeated measurement design. The experiment had three different conditions: silent condition, Mozart’s piano sonata no K448 music condition and soft relaxing music condition. Each participant was participated in three conditions and there was an one day gap before each conditions. Participants had to fill up the answer sheets of Raven's Progressive Matrices task book’s subset C and D.

As indicated that there will be difference between silent condition and soft-relaxing music condition. Paired sample t-test (table 2) indicates that there is a difference between these two conditions because the value in the "Sig. (2-tailed)" row is less than 0.05. The table 3 indicates that there is a difference between Mozart sonata K-448 condition and silent condition because the value in the "Sig. (2-tailed)" row is less than 0.05. The fourth table showed that there is a difference between Mozart sonata K-448 condition and oft-relaxing music condition.

An independent-sample t-test was conducted (table 6) to compare mean difference of average correct response of soft-relaxing music condition and Mozart Sonata K-448 music condition by gender. Table 6 indicates that there is no significant difference in the mean correct response in soft-relaxing music condition between female and male, Mozart sonata K-448 condition and male and female. Which means the results of the study support the hypothesis.

Though there are a few limitations that should be checked and taken into account during future attempts to extend upon this present study, it was not possible to work in a soundproof room. Irrelevant sound created problems with music condition and response time. In the future, it is advice to use a sound proof room.

References

Bodner, Mark & Zhou, Y-D & Shaw, G &Fuster, Joaquin. (1997). Symmetric temporal patterns in cortical spike trains during performance of a short-term memory task. Neurological research. 19. 509-14.

Bower, B. 1994. Tuning up young brains. Science News, 146 August: 143

Bridgett, D. J., & Cuevas, J. (2000). Effects of Listening to Mozart and Bach on the Performance of a Mathematical Test. *Perceptual and Motor Skills*, *90*(3_suppl), 1171–1175.

Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices Test. *Psychological Review*, *97*(3), 404–431.

Chase, R. A. (1966). “The effect of temporal lobe lesions on some auditory information processing tasks in man.”. In Brain mechanisms underlying speech and language, Edited by: Darley, F. L. New York: Grune and Stratton.

Donnon, Tyrone &DesCôteaux, Jean-Gaston &Violato, Claudio. (2005). Impact of cognitive imaging and sex differences on the development of laparoscopic suturing skills. Canadian journal of surgery. Journal canadien de chirurgie. 48. 387-93.

Eliot, J. (1980) Classification of figural spatial tests. Perceptual and Motor Skills, 51, 847–851.

Eliot, J. ,& Smith, I. M. (1983) An international directory of spatial tests. Windsor, UK: NFER-Nelson

Husain, G., Thompson, W. F., & Schellenberg, E. G. (2002). Effects of musical tempo and mode on arousal, mood, and spatial abilities. *Music Perception, 20*, 151–171.

Holden, C. (1994). Smart music. Science, 266: 968

Leng, X., & Shaw, G. L. (1991) Toward a neural theory of higher brain function using music as a window. Concepts in Neuroscience, 2, 229–258

Maccoby E.E., Jacklin C.N. (1978). The Psychology of Sex Differences. Stanford University Press.

Mountcastle, V. B. (1997) The columnar organization of the neocortex. Brain, 120, 701–722

Nantais, K. M. (1997) Spatial-temporal skills and exposure to music: is there an effect, and if so, why? Unpublished master's thesis, Univer. of Windsor, Windsor, Canada

Nantais, Kristin & Schellenberg, E.. (1999). The Mozart Effect: An Artifact of Preference. Psychological Science.

Newman, J., Rosenback, J. H., Burns, I. L., Latimer, B. C., Matocha, H. R., & Vogt, E. R. (1995) An experimental test of “the Mozart effect”: does listening to his music improve spatial ability? Perceptual and Motor Skills, 81, 1379–1387.

Rauscher, F. H., Hughes, J. L., & Miller, R. J. (1996) Music-induced mood affects spatial task performance. Presented at the meeting of the American Psychological Society, San Francisco, CA.

Rauscher, F.H., & Shaw, G.L. (1998). Key components of the Mozart effect. Perceptual and Motor Skills, 86, 835–841.

Rauscher, F. H., Shaw, G. L., & Ky, C. N. (1993). Music and spatial task performance. Nature, 365, 611.

Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1995). Listening to Mozart enhances spatial-temporal reasoning: towards a neurophysiological basis. *Neuroscience Letters*, *185*, 44–47.

Rauscher, F., Shaw, G., Levine, L., Wright, E., Dennis, W., & Newcomb, R. (1997). Music training causes long-term enhancement of preschool children’s spatial–temporal reasoning. *Neurological Research*, *19*, 2–8.

Reed, S.K. (2007). Cognition: Theory and Applications (7th Ed.) Thomson and Wadsworth Publishers. pp-3-4, 119.

Rideout, B. E. ,& Laubach, C. M. (1996) EEG correlates of enhanced spatial performance following exposure to music. Perceptual and Motor Skills. 82 4 27–432.

Roediger, H.L., III, & McDermott, K.B. (1993). Implicit memory in normal human subjects. In F. Boller& J. Grafman (Eds.), Handbook of neuropsychology, Vol. 8 (pp. 63–131). Amsterdam: Elsevier.

Sarnthein, J., vonStein, A., Rappelsberger, P., Petsche, H., Rauscher, F., & Shaw, G. (1997). Persistent patterns of brain activity: An EEG coherence study of the positive effect of music on spatial-temporal reasoning. *Neurological Research*, *19*, 107–116.

Schreiber, E. H. (1988). Influence of music on college students' achievement. Perceptual and Motor Skills, 66: 338

Shaw, G. L., Silverman, D. J., & Pearson, J. C. (1985) Model of cortical organization embodying a basis for a theory of information processing and memory recall. Proceedings of the National Academy of Science USA, 82, 2364–2368.

Stumpf, H., & Eliot, J. (1995) Gender-related differences in spatial ability and the k factor of general spadai ability in a population of academically talented students. Personality and Individual Differences, 19, 33–45.

Wagner, M. and Menzel, M. (1977). The effect of music listening and attentiveness training on the EEGs of musicians and nonmusicians. Journal of Music Therapy, 14: 151–164.

Wilson, T. L. ,& Brown, T. L. (1997) Reexamination of the effect of Mozart's music on spatial-task performance. Journal of Psychology, 131(4), 371–382.

Zaslaw, Neil, The Complete Mozart: A Guide to the Musical Works, p. 301 (New York, 1990)

Appendix

1. Instruction to the Participant
2. Demographic and Personal Questionnaire Sheet
3. Random Digit List
4. Response Sheet