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Effects of Musical Training and Listening to Mozart on Preschool Children's Verbal Reasoning and Numerical Memory

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ABSTRACT

Objective: This research is aimed at comparing the effects of musical training and listening to Mozart on both male and female Kerman City preschool children's verbal reasoning and numerical memory in 2012-13 educational year.
Method: An experimental-intermediary study that was carried out based on pre-test and post-test research design with control group, this research included 52 preschool male and female children, who were selected randomly in two groups of musical training and listening to Mozart. Musical activities were completed in 20 sessions of 75 minutes each allocated to training and rehearsal in the Orff Approach at the test group, and 20 sessions of 75 minutes each allocated to listening to Mozart's *D major* key at the control group. Wechsler test was conducted on both groups before and after the interventions. Data analysis was carried out by one-way covariance statistical method.
Findings: Results showed that the children attended at musical training sessions have significantly gained higher scores ($p<0.001$) than those listening to Mozart in terms of verbal reasoning and numerical memory.
Conclusions: This is concluded that attendance in group-based musical training sessions is effective on preschool children's verbal reasoning and numerical memory.
KEY WORDS: musical training; Mozart music; verbal reasoning; numerical memory; preschool children

INTRODUCTION

Non-musical effects of musical training are examined and the results show that they are mostly alluded to the childhood. Education in primary phases of childhood is of paramount importance in terms of sensitivity and receptivity of children from educational environments and sustainability of learning. Primary leaning is an appropriate context for children's upcoming transactions; in fact, what are learnt in the childhood are more enduring and difficult to forget (Ghasem Tabar et al., 2011). In the recent decades, musical learning has been taken into account as an effectual strategy to increase communicational, cognitive, and emotional capabilities of the children. Most trainers and experts believe that musical responses of children are the most natural reactions which play important roles in various learning respects (Noor Mohammadi, 2004).

In the recent years, there has been different scientific research (Bilhartz, Bruhn, and Olson, 2000) whose main common point has been the result that musical training is effective on cognitive growth and abstract thought. Gardner addresses music as an organizer of children's cognitive processes (cited by Ruscher and Zupan, 200). Research indicates that musical lessons have positive relationship with performance in verbal abilities (Marques, Moreno, Castro, and Besson, 2007; Moreno et al., 2008; Patel and Iversen, 2007; Shelenberg, 2005), phonology awareness (Shelenberg, 2008), spatial reasoning (Hetlnd, 2000), mathematics (Vaughn, 2000), memory (as inJakobson, Lewycky, Kilgour & Stoesz, 2008; Lee, Lu &Ko, 2007; Stoesz et al., 2007; Rusher et al., 1997), and IQ (Shelenberg, 2004).

In describing the fact that musical capabilities and spatial reasoning abilities are related, Leng and Shaw (1991) put forward the "trion model of the cortex," based on which certain neuron activity patterns that are arranged in vast areas of the cortex for mental spatial-time processes are used for both spatial reasoning and musical activities. EEG-aided studies support Trion model of the cortex. Leng and Shaw's model, together with theory of children's early sensitivity to music(Krumhansl and Jusczyk, 1990; Olsho, Schoon, Sakai, Turpin, and Sperduto, 1982), proposes the theory that musical training causes an improvement and evolution of neural paths involved in environment-dependent cognitive processes including spatial abilities. According to Hebb learning principles, making reparative use of this neural network through musical learning can make it more capable to complete other abilities (Le Fransoa, 2000: 171). Based on above-mentioned studies and aligned with them, this research is aimed at investigating the effects of musical training on children's spatial-time abilities. There is overlapping between areas related to cortex's verbal abilities (BA22 and Wernicke's area) and areas of temporal stratum which is engaged for professional musical activities (Lots, 2003). Since, according to conducted studies (Amirian, 2001; Mirbaha, 2005; Herrara, 2011; Bulduc, 2009; Hyward, 2009; Jausovec, 2006; Gromko, 2005; SchmitHorres, 2004; Rauscher, 2003; Ho, 2003; Gromko, 1998; Rauscher, 1997; Eugenia, 1999), musical training grows verbal abilities such as phonological awareness, verbal reasoning, and verbal memory, this research intends to discover the relationship between musical training and verbal abilities.

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According to Schlenberg (2011a), 144 preschool children were divided into two groups, one of which was trained for 36 weeks and the other left untrained. Wechsler intelligence scale was used. Post-test showed that test group had significantly better scores in intelligence test as compared to control group.

Schlenberg (2011c) investigated the relationship between musical lessons and intelligence in 106 male and female children of 9 to 12 years using Wechsler intelligence scale. 50 children were trained music for averagely 2 to 3 years and 56 children were left untrained. One-way variance analysis indicated that trained group had significantly higher IQ rates than their untrained counterparts ($P<0.001$, $F=17.72$).

Franklin, Rattray, Moore, Moher, Yip, and Jonides (2008) in their research in the University of Michigan examined the impact of musical practices on verbal memory of 20 musicians of 10 years of experience using Reiven test and verbal memory. T-test showed that musicians gained significantly higher scores in verbal memory ($P<0.004$, $F=3.17$).

In his study, Schlenberg (2006) investigated the relationship between musical training and IQ in Toronto, Canada, in 147 children of 6 to 11 years of age including 72 boys and 75 girls who had experienced musical training sessions for 23 months using Wechsler intelligence scale. Results of correlation test demonstrated that there is a positive and significant relationship between musical training and verbal IQ ($p<0.001$, $r=0.34$).He conducted the same study on 150 students of 16 to 25 years of age including 112 females and 38 males to examine the correlation between cognitive abilities in adulthood and musical training in childhood in those who have experienced musical training sessions for an average of 3.7 years. Results showed that subjection to music in childhood has a positive relationship with IQ and educational performance ($p<0.01$, $r=0.23$ and $p<0.05$, $r=0.21$).

Since the conducted research affirms the effectiveness of musical training, this study aims to examine the impact of musical training on verbal reasoning and numerical memory as compared to listening to Mozart in both male and female Kerman's preschool children in 2012-13 educational year.

Following questions are put forward:

1. Does musical training of preschool children cause an improvement of their verbal reasoning as compared to those who have listened to Mozart?
2. Does musical training of preschool children cause an improvement of their numerical memory as compared to those who have listened to Mozart?

METHODOLOGY

This research is a practical study in its objective, for which a pseudo-tentative methodology together with pretest and post-test states is used. 52 children were randomly selected and divided into training group and Mozart group, the members of the former of which were trained for 20 weeks (one session of 75 minutes per week) and the member of the latter were exposed to Mozart's *D major*key for 20 weeks (one session of 75 minutes per week). After termination of the sessions, post-tests were conducted on both test and control groups. Statistical analysis of the results was carried out by covariance analysis where all its suppositions were taken into account: normal distribution, linearity, reliability of covariant variable, homogeneity of variances, and reliability of regression gradient. Diagrams of normal distribution and linearity suggested non-violence, just as homogeneity of variances and reliability of regression gradient did, as shown in the Table 2.

Table 1: homogeneity of variances

Variables	F	First intergroup degree of freedom (df1)	Second intergroup degree of freedom (df2)	Level of significance
Verbal reasoning	3.02	1	50	0.088
Numerical memory	0.19	1	50	0.66

Table 2: homogeneity of regression gradient

Variables	Sum of squares	F	Level of significance
Verbal reasoning	21.00	3.26	0.07
Numerical memory	23.00	2.8	1

Statistical Community, Samples, and Sampling

Statistical community of this research includes all Kerman's preschool children in 2012-13 educational year. One preschool center was randomly selected and sampled by cluster random sampling method. In this research, from among all preschool centers from Kerman Province, one center was firstly selected. Then, 26 students were randomly selected for test group and the same number of students for the control group.

Instruments of the Research

Wechsler intelligence scale for children(1974) was utilized for measuring verbal reasoning and numerical memory of children between 5 to 15 years of age. It consists of measurement of verbal and nonverbal abilities in 12 equally divided subtests (Ganji, 2007: 385).Overall, ten tests are carried out to calculate IQ (Ganji, 2007: 182). Reliability coefficient of all

subtests and three verbal, nonverbal, and total scales were calculated for 7.5, 10.5, and 13.5 years in even-odd manner (ibid, 2007: 385).Reliability coefficient of Cronbach's alpha was calculated to be 0.72.

Table 3: A summary of musical training package inOrff Approach

Sessions	Training axes	Sessions	Training axes
Before the program	Pre-test	5th session	Teaching notes' traction and their written form
1st session	Acquaintance and communication Familiarity with sound characteristics		
2nd session	Teaching notes' sequence and their names Teaching thrumming Rehearing concentration Musical games to improve audition and mental accuracy	6th session	Rehearsing notes' traction on a new piece Developing rhythm recognition as well as emotional and motional precision
		7th session	Familiarity with silence in music
3rd session	Teaching *de major* key Teaching notes on five carrier lines Improvement ofpitches recognition and quality of sounds	8th session	Teaching new music Developing imagination, visualization, and creativity.
		9th session	Group rehearsals for more coordination
4th session	Teaching a short lyrics-included piece Developing motional skills, body coordination, rhythm recognition, and motional precision	10th session	Performing a demo concert for parents
		After the program	Post-test

Findings

Descriptive findings are demonstrated in Table 4. Scores averages of training group and Mozart group in verbal reasoning and numerical memory have no significant difference in pretest; however, musical training group could gain higher scores in both verbal reasoning and numerical memory compared to Mozart group.

Preliminary investigations to assure non-violence of assumptions' normality, linearity, homogeneity of variances, homogeneity of regression gradients, and reliability of covariance variables were also carried out (Tables 1 and 2). As seen in Table 5, effects of verbal reasoning pretest ($p<0.001$, $F=31.82$) and numerical memory ($p<0.05$, $F=0.70$) have been statistically effective. In other words, pretest score has had an effect in posttest, and some of variance of posttest scores has been impacted by pretest. Afterwards, to examine intermediary effect on the dependent variable, pretest effect was omitted as covariate variable. After pretest sores were adjusted, a significant difference between two test and control groups in score average of verbal reasoning ($p<0.001$, F(49.1)-96.84,Eta-square-0.664) and numerical memory ($p<0.001$, F(49.1)-65.34,Eta-square-0.571) was obtained.

Table 4: Average of subjects' scores in pre- and post-tests

Indices		Training group		Mozart group	
Tests		Average	SD	Average	SD
Verbal reasoning	Pretest	6.69	2.76	5.92	3.88
	Posttest	14.61	2.85	7.00	3.69
Numerical memory	Pretest	3.76	1.63	3.42	1.79
	Posttest	12.80	2.71	6.07	3.24

Table 5: Covariance analysis of research variable

Tests		Sum of squares	Mean of squares	F	Level of significance	Eta-square	Average adjusted Mozart	Average training Mozart
Verbal reasoning	Pretest	215.05	215.0	31.82	0.001	0.394	-	-
	Posttest	654.38	654.38	96.84	0.001**	0.664	7.28	14.48
Numerical memory	Pretest	31.46	37.46	3.70	0.05	0.07	-	-
	Posttest	557.36	557.36	65.34	0.001**	0.571	6.5	12.72

** $p\leq0.001$

According to the average adjusted scores of music group, i.e., 14.48, as compared to that of Mozart group, i.e., 7.28, Eta-square obtained for each variable indicates that IQ test of musical training caused an increase in verbal reasoning scores in training group. Effect/difference amount is equal to 0.664 and 66.4 percent of total variance of verbal reasoning scores verifies musical training. Therefore, the answer to the first research question "Does musical training of preschool children cause an improvement of their verbal reasoning as compared to those who have listened to Mozart?" is positive. Effect of musical training, in fact, is the reason for average differences of posttests as to pretests.

Numerical memory indicates eta square equal to 0.571, which, according to average adjusted scores of verbal reasoning of music group (12.72) as to that of Mozart group (6.5), is 57.1 percent of personal differences in numerical memory post-test scores, is associated with musical training. Therefore, the answer to "Does musical training of preschool

children cause an improvement of their numerical memory as compared to those who have listened to Mozart?" is positive. Effect of musical training is, in reality, the reason for average differences of posttests as to pretests.

DISCUSSION AND CONCLUSIONS

The chief purpose of this research was to investigate the relationship between musical training and listening to Mozart, on the one hand, and verbal reasoning and numerical memory of Kerman's preschool children, on the other. With regard to negating effects of pretest, this can be stated that musical training (Orff, in this research) has been effective in increasing children's verbal reasoning and also in numerical memory of training group compared to those who had listened to Mozart. This is aligned with results of Hererra et al. (2011) and Gromko (2004), who concluded that musical training leaves a positive impact on verbal reasoning. One-way covariance analysis as used to obtain the answer to the second question.

After pretest effects were negated, a significant difference was observed between scores of the subjects in Mozart group in numerical memory (training group average=12.72, Mozart group average=6.5) in $F=65.34$ in the level of $p<0.001$. In other words, scores of test group in numerical memory were higher than Mozart group as a result of musical training. Examination of averages in two groups indicates that posttest score of training group is increased as compared to that of Mozart group.

This is, therefore, safe to assert that musical training provokes increased numerical memory in the group subject to musical training. Consequently, the answer to the research question "Does musical training of preschool children cause an improvement of their numerical memory as compared to those who have listened to Mozart?" is positive. This is in line with Mirbaha (2003), Amirian (2011), Khalaf Beigi, Bayan Zadeh, Zadeh Mohammadi, and Shafaroudi (2006) as well as Bulduk (2009), who studied the effect of musical training on short-term memory, phonological memory, auditory memory, and attention. To delineate this finding, this is to note that musical training calls for broad utilization of memory.

Also, some games focus on strengthening the human memory. According to Hebbian learning principles, making reparative use of certain brain sections strengthen used paths and their performance, making them more active (Le Fransoa, 2000: 165). In Javsovec et al. (2006), EEG indicated that Mozart music activates the sections involved in memory-related tasks. According to this research, musical training has significant impact on verbal reasoning and numerical memory of preschool children.

Importance of education and training in preschool periods is presently taken into more account than before (Yazd Khasti, 1998). Nasri (2000) indicated that the students who have passed the preschool period in relevant educational centers are equipped with more social compatibility than those who have not passed the same. Moreover, passing preschool period stimulates learning (Mohammadi, 1995), and educational progress and social development (Sahebi, 2000). Education before elementary school through environmental enrichment enables children to achieve new perceptive and mental experiences which are impossible to be gained in general familial atmospheres. Therefore, education before formal schools has found vital importance and many countries have focused their attention thereon.

Since children are in constant give-and-takes with the environment, the more enriched and user-friendly the environment, the higher the impression of the children from the environment. The interval from three to six years of age is the span in which the personality shapes. In addition, the prominent function of the education in preschool years is making children acquaint ant with social life. Among other objectives of education are physical-motional growth, language and discourse development, cognitive growth, and creative evolution (Yazd Khasti, 1998).

Since musical training is effective on cognitive and social development of children especially in preschool periods, it can be taken advantage of in assisting children to grow socially and cognitively parallel with other preschool training courses.

PERSIAN RESOURCES

Amirian, Kamran (2011). "Impact of Musical Training on Intelligence Abilities of Kermanshah's Youngsters," article collection in the third cross-country art therapy congress in Iran

Khalafbeigi, Mitra; Bayan Zadeh, Seyed Akbar; Zadeh Mohammadi, Ali; Shafaroudi, Narges (2006)."Impact of Musical Activities on Memory and Attention in Schizophrenia." Iran's Psychiatry and Psychology Journal. 12 (2): 236-243

Ghasem Tabar, Seyed Nabiollah; Mofidi, Farkhondeh; Zadeh Mohammadi, Ali; Ghasem Tabar, Seyed Abdollah (2011)."Impact of Musical Training on Basic Mathematical Abilities of Preschool Children: Iranian Psychologists" 27 (7): 245-254

Ganji, Hamzeh (2007).*Psychic Tests: Theoretical and Practical Basics* (ninth version). 2nd ed., Tehran: Savalan Pubs.

Mirbaha, Hilda (2003). "Impact of Musical Training on the Infants' Intelligence Abilities. "News in Cognitive Sciences Journal. 3: 47-54

Nour Mohammadi, F. (2004).“Impact of Orff Music on Improvement of Time Structuring (Tempo): Iranian Psychologists” 2: 119-135

Yazd Khasti, Ali (1998).“The Role of Preschool Centers in Integrative Growth of Children” Peyvand Journal of Psychology and Educational Sciences. 233: 48-57

ENGLISH RESOURCES

Bulduc, J. (2009). Effect of a music programs on kindergarteners’ phonological awareness skills, *International Journal of Music Education,*27(1): 37-47.

- Bilhartz, T.D.; Bruhn, R.A.; & Olson, J.E.(1999). The effect ofearly music training on child cognitive development. *Journal ofApplied Developmental Psychology, 20*(4), 615-636.

- Franklin, M. S.; Rattray, K.; Moore, K. S.; Moher, J.; Yip, C.-Y. &Jonides, J.(2008). The effects of musical training on verbal memory. *Psychology of Music,36*(3): 353-365.

- Gromko, J.E.(2004). Predictors of music sight-reading ability in high school wind players. *Journal of Research in Music Education*, *52*(1): 6-15.

- Gromko, J.E.(2005). The effect of music instruction on phonemic awareness in beginning readers. *Journal of Research in Music Education, 53*: 199-209.

- Gromko, J.E.; Poorman A. S.(1998). The effect of music training on preschooler`s spatial- temporal task performance. *Journal of Research in Music Education,46*(2): 137-182.

- Hayashia, A.; Nagaokab, M.; Mizuno, Y.(2006). Music therapy in parkinson’s disease: Improvement of parkinsonian gait and depression with rhythmic auditory stimulation. *Parkinsonism and Related Disorders*,12: 76.

- Hayward, C. M.; Gromko, J.E.(2009). Relationship among music sight reading & technical proficiency, spatial visualization, & aural discrimination. *Journal of Research in music education, 27*(1): 26-36.

- Herrera, L.; Lorenzo, O.; Defior, S.; Graded, F.S.; Costa-Giomo, E.(2011). Effects of phonological and musical training on the reading readiness of native- and foreign-Spanish-speaking children. *Psychology of Music, 39*(1): 68-81.

- Hetland, L. (2000). Learning to make music enhancesspatial reasoning. *Journal of Aesthetic Education*, *34*,179- 238.

- Ho, Yim-Chi; Cheung,Mei-Chun; Chan, S.A.(2003). Music training improves verbal but not visual memory: Cross- sectional & longitudinal explorations in children. *Neuropsychology, 17*(3): 439-450.

- Jakobson, L. S., Lewycky, S. T., Kilgour, A. R., &Stoesz, B. M.(2008). Memory for verbal and visual material in highly trained musicians. *Music Perception*, *26*: 41-55.

- Jausovec, N.; Jausovec, K.; Gerlic, I.(2006). The influence of Mozart’s music on brain activity in the process of learning. *Clinical Neurophysicology, 117*: 2703- 2714.

- Lee, Y.; Lu, M., &Ko, H. (2007). Effects of skill training on working memory capacity. *Learning and Instruction, 17*: 336-344.

- Leng, X., & Shaw, G.L. (1991). Toward a neural theory ofhigher brain function using music as a window. *Concepts onNeuroscience, 2*, 229-258.

- Lotze, M.; Scheler, G.; Tan, H.R.; Braun, C. M. &Birbaumer, N.(2003). The musician’s brain: Functional imaging of amateur professionals during performance and imagery, *NeuroImage,20*, 1817-1829.

- Marques, C.; Moreno, S.; Castro, S. L. &Besson, M.(2007). Musicians detect pitch violation in a foreign language better than nonmusicians: Behavioral and electrophysiological evidence. *Journal of CognitiveNeuroscience, 19*: 1453-1463.

- Moreno, S.; Marques, C.; Santos, A.; Santos, M.; Luis Castro, S. &Besson, M. (2008). Musical training influences linguistic abilities in 8-year-old children: More evidence for brain plasticity. *Cerebral Cortex*. 19, 712-723.

- Münzer, S.; Berti, S. &Pechmann, T.(2002).Encoding of timbre, speech, and tones: Musicians vs. nonmusicians. *PsychologischeBeiträge*, *44*, 187-202.

- Olsho, L.W.; Schoon, C.; Sakai, R.; Turpin, R. &Sperduto, V.(1982). Auditory frequency discrimination in infancy.*Developmental Psychology, 18*, 721-726.

- Patel, A. D. &Iversen, J. R.(2007). The linguistic benefits of musical abilities. *Trends in Cognitive Sciences,11*: 369-372.

- Piro, J. M. &Ortize, G.(2009). The effect of piano lessons on the vocabulary and verbal sequencing skills of primary grade student. *Psychology of Music, 37*(3): 325-347.

- Pool, J. & Odell-Miller, H.(2011). Aggression in music therapy and its role in creativity with reference to personality disorder. *The Arts in Psychotherapy*, *38*: 169-177.

- Rauscher, F.H.; Shaw, G.L.; Levine, L.J.; Wright, E.L.; Dennis, W.R. & Newcomb, R.(1997). Music training causes long-term enhancement of preschool children's spatial-temporal reasoning abilities. *Neurological Research*, *19*: 1-8.

- Rauscher, F.H.(1999). Music exposure and the development of spatial intelligence in children. *Bulletin of the Council for Research in Music Education*, *142*: 35- 47.

- Rauscher, F.H. &Zupan, M.A.(2000). Classroom keyboard instruction improves kindergarten children's spatial temporal performance: A field experiment. *Early Childhood Research Quarterly, 15*: 215-228.

- Rauscher, F. H. and Hinton, S. C.(2003). *Type of music training selectively influences perceptual processing* .Hannover , Germany : Hannover University Press.

- Register, D.M. & Hilliard R.E.(2008). Using Orff-based techniques in children's bereavement groups: A cognitive-behavioral music therapy approach. *The Arts in Psychotherapy, 32*:162-170.

- Repp, B.H. (1995). Detect ability of duration and intensity increments in melody tones: a partial connection between music perception and performance. *Perception and Psychophysics*, *57*, 1217-1232.

- Santoz-Luiz, C.(2007).*The* learning of music as a means to improve mathematical skills. *International Symposium on Performance Science ISBN*, 78-90.

- Schellenberg, E.G.(2011a). Music lessons enhance IQ. *Psychological Science,15*(8), 511-514.

- Schellenberg, E.G.(2011b).Music Lessons, Emotional Intelligence, and IQ. *Music Perception*, *29*(2): 185–194.

- Schellenberg, E.G.(2011c).Examining the association between music lessons and intelligence. *Journal of Psychology, 102*: 283–302.

- Schellenberg, E. G. &Peretz, I.(2008). Music, language, andcognition: Unresolved issues. *Trends in Cognitive Sciences, 12*: 45–46.

- Schellenberg, E.G.(2007). Exposure to music and cognitive performance: tests of children and adults. *Psychology of Music*, 35(1): 5–19.

- Schellenberg, E.G.(2006). Long-Term Positive Associations Between Music Lessons and IQ, *Journal of Educational Psychology*, *98*(2): 457- 46.

- Schellenberg, E. G. (2005). Music and cognitive abilities. *Current Directions in Psychological Science,14*:322-325.

- Schmithorst, V.S.; Holland, S.K.(2004). The effect of musical training on the neural correlates of math processing: a functional magnetic resonance imaging study in humans, *Neuroscience Letters,354*: 193-196.

- Stoesz, B. M.; Jakobson, L. J.; Kilgour, A. R. &Lewycky, S. T.(2007). Local processing advantage in musicians: Evidence from disembedding and constructional tasks. *Music Perception,25*: 153-165.

- Thompson, W. F.; Schellenberg, E. G. & Husain, G.(2001). Arousal, Mood, The Mozart effect. *Psychological Science*, *3*(12): 248-251.

- Vaughn, K.(2000). Music and mathematics: Modest support for the of-claimed relationship. *Journal of Aesthetic Education*, 34(3/4) :149-166.