The differential effect of music on the working memory of musically trained and non-trained undergraduate students

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Abstract:

The aims of this study were to determine differential effect of music on the working memory, as measured by Digit Span Test, Visual pattern Test, word recall test and Backward Digit Recall Test of trained and non-trained undergraduate students. (60) undergraduate students from faculty of specific education, Cairo university participated in this study. There were (30)

(18 females, 60% and 12 males ,40%) and musically trained, and (30) (20 females , 66.6% and 10 males 33.3%) musically non- trained. There aged (20-21) years old average age=20.7 years. Results showed that there were significant difference between musically trained and non-trained undergraduate students on All test of working memory in favor of musically trained students.

Keywords. Music, working memory, musically trained, non-trained, undergraduate students

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التأثير التفاضلي للموسيقى على الذاكرة العاملة لطلبة المرحلة الجامعية المدربين وغير المدربين موسيقيًا

المستخلص:

هدفت الدراسة إلي تحديد التأثير التفاضلي للموسيقى على الذاكرة العاملة، كما تم قياسه بواسطة اختبار المدى الرقمي، واختبار النمط البصري، واختبار استدعاء الكلمات غير الصحيحة واختبار استدعاء الأرقام بالعكس للطلاب الجامعيين المدربين وغير المدربين موسيقيًا. أجريت الدراسة على عينة قوامها ٦٠ طالبًا جامعيًا من كلية التربية النوعية بجامعة القاهرة، شاركوا في هذه الدراسة. كان هناك (٣٠) طالباً منهم (١٨ إناث بنسبة ٦٠٪ و ١٢ ذكور بنسبة٤٠٪) مدربين موسيقيًا، و(٣٠) طالباً منهم (٢٠ إناث بنسبة ٦٦.٦٪ و١٠ ذكور بنسبة ٣٣.٣٪) غير مدربين موسيقيًا. تراوحت اعمارهم ما بين (٢٠-٢١) سنة بمتوسط عمري (٢٠.٧) سنة، أظهرت النتائج وجود فروق ذات دلالة احصائية عند مستوى دلالة (٠,٠١) بين طلاب البكالوريوس المدربين موسيقياً وغير المتدربين في اختبار الذاكرة العاملة بالكامل لصالح الطلاب المدربين موسيقياً.

The differential effect of music on the working memory of musically trained and non-trained undergraduate students

Introduction:

Music is a universal phenomenon, that is found in all cultures (Perlovsky, 2012) and can be regarded as a part of most of our lives as an integral element of recreational and entertainment activities, a component in religious and spiritual pursuits, a relaxation and calming tool in times of stressful situations such as examination preparation and traffic jams(Pakeezah Rajab & Michael Pitman,2019).

Working memory is defined as the ability to hold, process, and manipulate information in memory is a core executive function ,and is important in both reasoning and decision-making(Myles,2017) . Working memory is very important in everyday life, being essential in situations where we are faced with activities that involve cognitive efforts. Working memory involves retaining information and working with it(Baddeley& Hitch,1994).

Long-term musical practice has been found to result in improvement of various auditory and cognitive skills such as auditory attention(Strait et al.,2010) auditory stream segregation (Beauvois & Meddis,1997) processing of emotion in speech (Strait,Kraus, Skoe& Ashley, 2009). working memory(Chan, Ho&Cheung, 1998) temporal resolution abilities,and processing of prosody and linguistic features in speech (Chandni ,Devi, Sindhu ,Parthasarathy& Kavitha, 2020).

Several cross-sectional studies have reported varying musician advantage in working memory tasks. For example, in a study by George and Coch (2011), years of musical training correlated positively with scores in both verbal and visual span tests for memory in college-aged individuals.

Previous research suggests that musical training is positively associated with WMC across the lifespan (Franklinet al., 2008; George & Coch, 2011; Hanna-Pladdy & Gajewski, 2012; Nutley, Darki, &Klingberg, 2014; Roden, Grube, Bongard, & Kreutz, 2014; Schulze, Dowling, & Tillmann, 2012). In a meta-analysis study, Talamini et al.'s (2017) reported that musicians outperformed their less musically trained

counterparts in long-term memory, short-term memory, and working memory tasks.

Hallam, Price and Katsarou (2002) found a different effect of music on working memory however. The primary grade students were separated into different groups and asked to complete a simple task to test their working memory ability under one of three conditions: silence, a music source quantified as calming and relaxing, or a music source quantified as aggressive (Hallam, Price & Katsarou, 2002). Mammarella, Fairfield and Cornoldi (2007) found that those who were assigned to the music condition performed significantly better than those listening to either white noise, or those who completed the task in silence.

Significance of the study

This study add to the literature concerning as it was found that musical training has shown improved cognitive abilities such as working memory and reading complex words(Chandni et al., 2020).

Research objectives

The aims of this study were to determine differential effect of music on the working memory of trained and non-trained undergraduate students.

Hypotheses

This study posed the following hypotheses:

1- There are significant differences between musically trained and non- trained undergraduate students on Digit Span Test in favor of musically trained students.
2- There are significant differences between musically trained and non- trained undergraduate students on Visual pattern Test in favor of musically trained students.
3- There are significant differences between musically trained and non-trained undergraduate students on Nonword recall test in favor of musically trained students.
4- There are significant differences between musically trained and non-trained undergraduate students on Backward Digit Recall Test in favor of musically trained students.

Methodology

60 undergraduate students from faculty of specific education, Cairo university participated in this study. There were 30 (18females, 60% and 12 males ,40%)and musically trained, and 30 (20 females , 66.6% and 10 males 33.3%) musically non- trained. There aged 20-21years old(m=20.7 years, SD= 1.02). Those musically trained undergraduate students were from Music Department, and all had musical instruments at home.

Instruments

Digit Span Test(Developed particularly for this study). A sequence of 14 series test . Subjects are read a sequence of numbers and asked to repeat the same sequence back to the examiner in order (forward span) .Forward span captures attention efficiency

and capacity. Forwards performance can be reported either as subscores (the number of correct items of each type) or as span scores (the maximum number of digits correctly produced forwards by the subjects). Approximately half (forwards 52%,) of the studies reviewed reported Digit Span scores. Test re-test reliability was .72 ($p < .01$).

Visual pattern Test(Developed particularly for this study). A series of five card, on which there are a group od squares some of them are colored , and the others are not. The subjects are asked to have a look upon each card for 5 secs. Then at the back of the card, they mark the place of the colored squares . each correct response has a point, while the incorrect one takes zero. Test re-test reliability was .70 ($p < .01$).

Word recall test(Developed particularly for this study). A series of six card, on which there are four sentences , graded in difficulty, from easy to most difficult .The subjects are asked to have a look upon each card for 5 secs. Then at the back of the card, they write the sentences in order . each correct response has a point, while the incorrect one takes zero. Test re-test reliability was .75 ($p < .01$).

Backward Digit Recall Test (Developed particularly for this study). A sequence of 14 series test . Subjects are read a sequence of numbers and asked to repeat the same sequence back to the examiner in order (backward span) .Backward span captures attention efficiency and capacity. Backward span is an executive task particularly dependent on

working memory. Backward performance can be reported either as subscores (the number of correct items of each type) or as span scores (the maximum number of digits correctly produced backwards by the subjects). Approximately half (backwards 48%) of the studies reviewed reported Digit Span scores. Test re-test reliability was .73 ($p < .01$).

Results

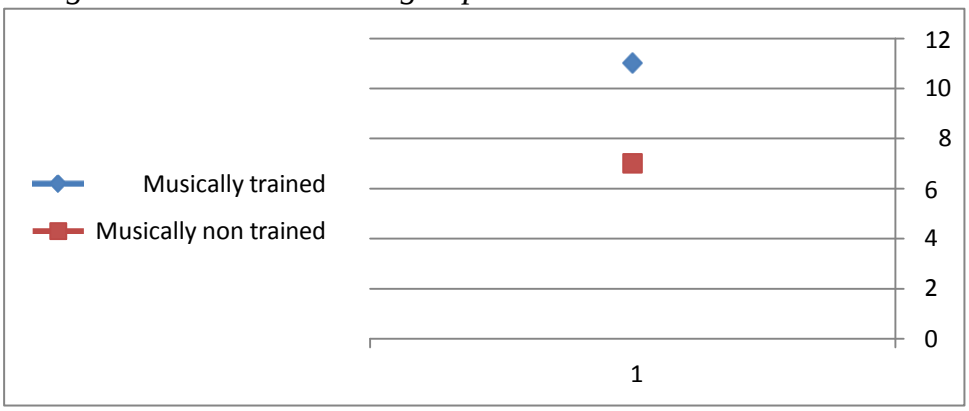
As to the first hypothesis ,"There are significant differences between musically trained and non- trained undergraduate students on Digit Span Test in favor of musically trained students", results as shown in table 1. and figure1, there are significant difference($p < .01$) between musically trained and non- trained undergraduate students on Digit Span Test in favor of musically trained students.

Table 1 . T-test results for the differences in post- test mean scores in digit span test

Variables	Group	N	Mean	Std. deviation	T	Sig.
Digit Span Test	trained.	30	11.182	1.02	6.55	.000
	No-trained.	50	7.228	1.40		

Note.: ETA Square = 0.829. High size effect (Cohen, 1988 suggested that =0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size).

Figure 1. *The difference between musically trained and non- trained undergraduate students on Digit Span Test*



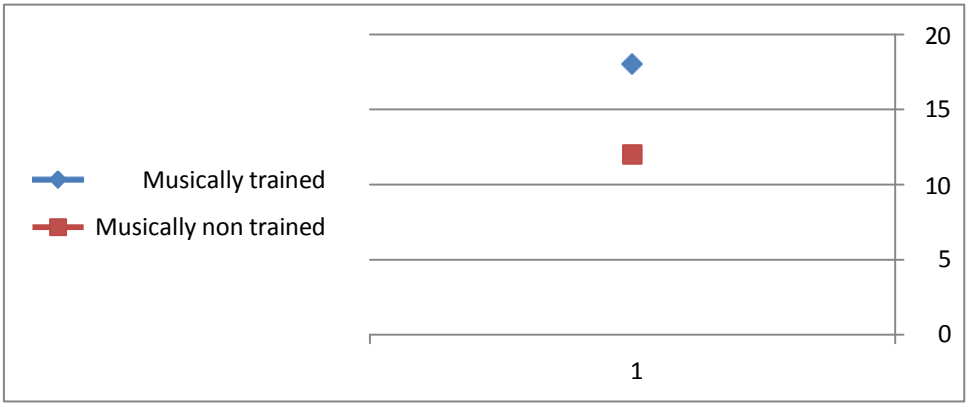
As to the second hypothesis ," There are significant differences between musically trained and non- trained undergraduate students on Visual pattern Test in favor of musically trained students ", results as shown in table 2 and figure 2 m there are significant differences ($p < .01$) between musically trained and non- trained undergraduate students on Visual pattern Test in favor of musically trained students.

Table 2 . T-test results for the differences in post- test mean scores in visual pattern test

Variables	Group	N	Mean	Std. deviation	T	Sig.
visual pattern test	trained.	30	18.161	1.22	7.11	.000
	No-trained.	50	12.111	1.15		

Note.: ETA Square = 0.820. High size effect (Cohen, 1988 suggested that =0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size).

Figure 2. *The difference between musically trained and non- trained undergraduate students on Visual pattern Test*



As to the third hypothesis ," There are significant differences between musically trained and non- trained undergraduate students on word recall test in favor of musically trained students ", results as shown in table 3 and figure 3,there are significant difference($p < .01$) between musically trained and non- trained undergraduate students on Nonword recall test in favor of musically trained students. As musically trained

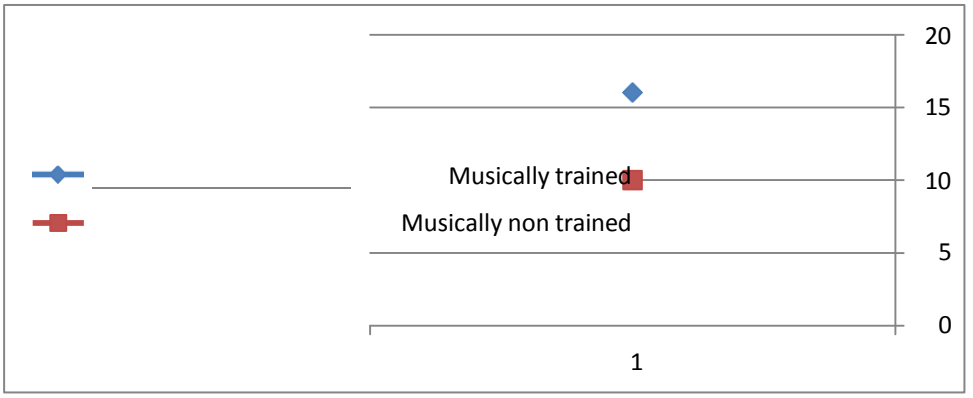
undergraduate students got 16 points(i.e. the number of correct items was 16) they , while non- trained undergraduate students got 10 (i.e. the number of correct items was 10).

Table 3 . T-test results for the differences in post- test mean scores in word recall test

Variables	Group	N	Mean	Std. deviation	T	Sig.
word recall test	trained.	30	16.121	1.28	7.11	.000
	No-trained.	50	10.103	1.19		

Note.: ETA Square = 0.821. High size effect (Cohen, 1988 suggested that =0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size).

Figure 3. *The difference between musically trained and non- trained undergraduate students on word recall test*



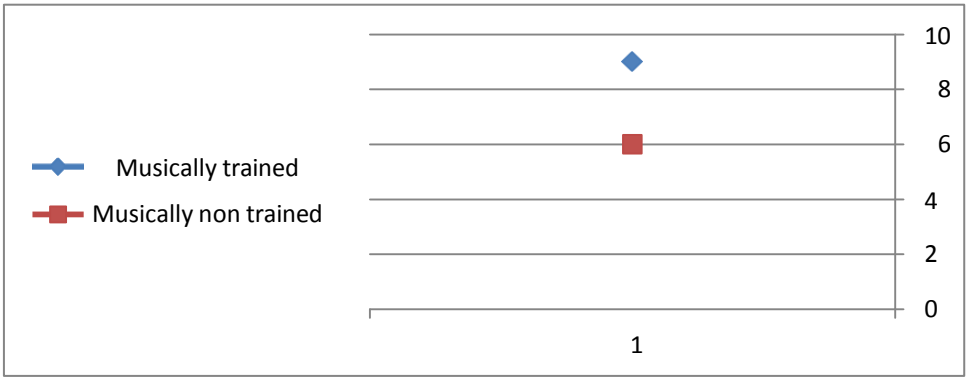
As to the fourth hypothesis ,"There are significant differences between musically trained and non- trained undergraduate students on Backward Digit Recall Test in favor of musically trained students", results as shown in table 5 and figure 4,there are significant difference($p < .01$) between musically trained and non- trained undergraduate students on Backward Digit Recall Test in favor of musically trained students. As musically trained undergraduate students got 9 points(i.e. the number of correct items was 9) they, while non- trained undergraduate students got 6(i.e. the number of correct items was 6).

Table 4 . T-test results for the differences in post- test mean scores in digit recall test

Variables	Group	N	Mean	Std. deviation	T	Sig.
Digit recall test	trained.	30	9.128	1.21	5.11	.000
	No-trained.	50	6.110	1.14		

Note.: ETA Square = 0.821. High size effect (Cohen, 1988 suggested that =0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size).

Figure 4. *The difference between musically trained and non- trained undergraduate students on Backward Digit Recall Test*



Discussion

The aims of this study were to determine differential effect of music on the working memory, as measured by Digit Span Test, Visual pattern Test, word recall test and Backward Digit Recall Test of trained and non-trained undergraduate students. Results showed that there were significant difference($p < .01$) between musically trained and non-trained undergraduate students on All test of working memory in favor of musically trained students.

Overall, although training using music appears to have positive effects on emotions and especially on motor behavior (such as athletic performance), it appears to impact on

the working memory, as measured by Digit Span Test, Visual pattern Test , Nonword recall test and Backward Digit Recall Test of trained and non-trained undergraduate students.

This results support those of Jakobson et al. (2008) who found that musicians outperformed non-musicians on the Rey Visual Design Learning Test. Results of Miller's study (2017) indicated that using retrieval learning strategies can lead to significantly better recall immediately after and one week later. The scores for participants in the musical groups were slightly higher than those in the speech groups, but the difference was not statistically significant. Talamini et al.'s (2017) meta-analysis reported that musicians outperformed their less musically trained counterparts in long-term memory, short-term memory, and working memory tasks. Further, the authors reported that task type moderated the relation between musicianship and memory performance. Roden et al. (2014) provided either music or natural science training to primary school-aged children over a period of 18 months, and found that the music group outperformed the natural science group on working memory tasks post-training.

Studies suggest that individuals with music exposure perform better in tasks measuring language abilities, such as foreign language pronunciation skills (Milovanov et al., 2010), phonological awareness (Linnavalli et al., 2018), and verbal intelligence (Moreno et al., 2012) than those who without music exposure.

To conclude, Musically trained individuals have been reported to outperform musically nontrained peers in various kinds of working memory tests(Digit Span Test, Visual pattern Test , Nonword recall test and Backward Digit Recall Test)

Future Research

Results from this study can assist in planning both future research endeavors, as well as implement further exploration into the current study. The division of students into musically trained and musically non-trained allowed differences in musical experience across participants to be noted. Future research should include a sample from one background.

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