

An investigation on the effects of music training on attention and working memory in adults

Bahar YEŞİL,¹ Süheyla ÜNAL²

ABSTRACT

Objective: Determining the effects of music training on attention and working memory in adult music trainees using neuropsychological tests. **Methods:** The study was conducted within January-June 2014 at the Music Department of İnönü University. Twenty-two students of age 18-26 were matched one to one in terms of age, gender, level of academic education and dominant hand. Participants with substance abuse, psychiatric and neurological disease were excluded from study. ASRS, Stroop and WMS-R were applied on first and fourth year students. **Results:** The sample consisted of 24 women and 20 men. The mean age was 22 ± 1.5 years and the mean academic level of education was 15 ± 1.5 years. There was no significant difference between first and fourth year students in terms of ASRS-A, ASRS-B and ASRS total scores. There was no significant difference between groups in pre-university music experience. Fourth year students were better at greyscale word reading, color word reading and box color statement in Stroop. There was no significant difference in word color statement. Fourth year students were better in reverse month counting and counting by sevens in WMS-R. No significant difference was found in countdown range, short and long-term verbal and visual recognition, memory, mental control and concentration. **Conclusion:** Long-term and regular music training did not affect attention shifting in adults significantly, but caused improvement in some tests requiring working memory activity. Irregular music experience did not have significant contribution. Regular and intensive music practice may have functional effects on cognition in adults. (*Anatolian Journal of Psychiatry* 2017; 18(6):531-535)

Keywords: music, attention, working memory, neuropsychological tests

Yetişkinlerde müzik eğitiminin dikkat ve çalışma belleğine etkilerine yönelik bir araştırma

Öz

Amaç: Yetişkin müzik öğrencilerinde müzik eğitiminin dikkat ve çalışma belleğine etkilerini nöropsikolojik testler kullanarak belirlemek. **Yöntem:** Araştırma Şubat-Haziran 2014 tarihleri arasında İnönü Üniversitesi Müzik Eğitimi Bölümü'nde yapılmıştır. On sekiz-yirmi altı yaşları arasındaki 22 öğrenci yaş, cinsiyet, akademik eğitim süresi ve baskın el yönünden eşleştirilmiştir. Madde kullanımı, psikiyatrik ve nörolojik hastalığı olan katılımcılar çalışmadan dışlandı. Birinci ve dördüncü sınıf öğrencilerine ASRS, Stroop ve WMS-R testleri uygulanmıştır. **Bulgular:** Katılımcıları 24 kadın, 20 erkek, toplam 44 öğrenci oluşturdu. Katılımcıların yaş ortalaması 22 ± 1.5 , akademik eğitim süresi ortalaması 15 ± 1.5 yıl idi. Lisans eğitimi öncesindeki müzik deneyimi açısından birinci ve dördüncü sınıflar arasında anlamlı fark saptanmadı. Birinci ve dördüncü sınıflar arasında ASRS-A, ASRS-B ve ASRS Toplam puanı açısından anlamlı fark saptanmadı. Dördüncü sınıf öğrencileri Stroop testinin siyah-beyaz sözcük okuma, renkli sözcük okuma ve kutu rengini söyleme aşamalarında birinci sınıflardan üstündü. Sözcüğün rengini söyleme aşamasında ise sınıf

¹ Uzm. Dr., Elazığ Ruh Sağlığı ve Hastalıkları Hastanesi, Elazığ

² Prof. Dr., İnönü Üniversitesi Tıp Fakültesi Psikiyatri ABD, Malatya

Correspondence address / Yazışma adresi:

Uzm. Dr. Bahar YEŞİL, Elazığ Ruh Sağlığı ve Hastalıkları Hastanesi, Rizaiye Mah. Kıbrıs Şehidi Mehmet Güçlü Cad. No.71 Elazığ, Türkiye

E-mail: baharyesilege@hotmail.com

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*grupları arasındaki farkın anlamlı olmadığı saptandı. WMS-R testinde dördüncü sınıf öğrencileri ayları geri sayma ve yedişer sayma aşamalarında birinci sınıflardan üstündü. Geri sayı menzili, kısa ve uzun süreli sözel ve görsel tanıma ve hatırlamayı ölçen testler ile zihinsel kontrol ve konsantrasyonu ölçen diğer testlerde ise anlamlı fark saptanmadı. **Sonuç:** Çalışmamızda yetişkinlerde uzun süreli ve düzenli müzik eğitiminin dikkati kaydırabilme becerisini anlamlı etkilemediğini, ancak çalışma belleği aktivitesi gerektiren bazı testlerde gelişmeye yol açtığını saptadık. Düzenli olmayan müzik deneyiminin ise anlamlı katkısı bulunmadı. Sonuç olarak düzenli ve yoğun müzik pratiğinin yetişkinlerde biliş üzerine işlevsel etkilerinin olabileceği düşünüldü. (Anadolu Psikiyatri Derg 2017; 18(6):531-535)*

Anahtar sözcükler: Müzik, dikkat, çalışma belleği, nöropsikolojik testler

INTRODUCTION

Music is a way of expression as old as humanity. Recent developments in neuroscience make it possible to research the functions of music which is already known for its reminder power and permanent effects in the memory. Instrument playing or music practice that are the components of music training enable cognitive improvements in musicians.¹ A formal kind of music practice includes long-time control of attention, storing of musical pieces in the working memory or their coding process in the memory, coding of notes and tones and transfer of the product into motor instructions. Working memory is responsible for both the unification of the notes and the continuity of our musical experience that causes affection. Besides, it is also active in acquiring some new behaviors automatized later such as playing instruments.² The relationship between attention and working memory is multidimensional and attention plays role in data transfer to the working memory.³ Multidimensional results have been found about the effects of music training on working memory. It is also found that music training is beneficial for attention time, intelligence, auditory, visual, motor and visuospatial skills.⁴ It is detected that musicians aged between 9-19 use their prefrontal cortex mediating for the working memory better at rhythmic tasks and they perform better than non-musicians.⁵ In a counter study, auditory working memory is studied via reverse number distance in adult musicians and no difference is found.⁶

In this study, neuropsychological tests were applied to the university students who took short term (6 months) and long term (42 months) formal music training to test the hypothesis that there can be improvements in the working memory with music training.

METHODS

Our cross-sectional study was conducted at the beginning month, February, of the spring term of

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2014 in İnönü University Education Faculty Music Department. There was no sampling process but all the volunteering freshman and senior year students were included in the study. Only the students succeed at knowledge test and special skills exam which aims to evaluate auditory skills are accepted to music department. These students take many courses varying from compulsory piano courses to selective instrumental training courses on any instrument that they choose among wind instruments, bow instruments, strings, percussion instruments. Students who take 6 months training were matched one-to-one with those who take 42 months training according to their age, gender, academic year and dominant hand. In the psychiatric evaluation done with SCID-I according to DSM-IV, exclusion criteria were determined as not having a psychiatric diagnosis, not having a neurological disease, not having a drug use disorder and being capable of performing the instructions of the study. Participants were informed about the goals of the study. Those whose personal participation forms were filled also filled Adult ADHD Self Report Scale (ASRS). In this personal information form, DEHB stories in childhood, mental illness in family history, musical experience before undergraduate studies and compulsory instrument group were examined besides sociodemographic variables. WMS-R and Stroop tests were applied to the participants by asking the questions one-by-one by the psychiatrist. Sociodemographic variables, ASRS scale points and WMS-R and Stroop test results were compared statistically. 2013/195 numbered ethics committee approval was taken from İnönü University Medical Faculty for the study.

Adult Attention Deficit and Hyperactivity Disorder (ADHD) Self Report Scale (ASRS) used in our study is the five point Likert type self-report scale consisting of 18 articles formed by World Health Organization (WHO) for ADHD. Nine articles were designed for attention deficit and the remaining nine were designed for hyperactivity disorder. Breakpoint for the total score of the

scale, the determined value is 37. With these numbers, specificity of the scale is determined as 92.3% and sensibility is 73.3%. Stroop test is a neuropsychological test that evaluate parallel processing skill of noticed stimuli and unnoticed stimuli, data processing speed and resistance skill to the damaging effects of automatic processes (interference).⁷⁻⁹ In our study, following stages were applied respectively: reading black and white color names, reading colorful names, naming colorful boxes, and naming color words. Wechsler Memory Scale Improved Form (WMS-R) includes subtests that test attention, tendency, instant verbal and virtual memory, learning activity, delayed recollection and recognition.¹⁰ Standardization of test in our country was done in the scope of BİLNOT battery.¹¹ The form of the scale used in our study consists of subtests of general knowledge, mental control, logical memory, reverse and smooth number repetition, figures memory and associative verbal learning.

Statistical analysis

In the analysis of data, SPSS (Statistical Package for Social Science for Windows) 21.0 was used. Descriptive statistics (percentages, average, and standard deviation) were used in the analysis of quantitative data and chi square test was used in the analysis of the categorical variables. Independent sample t test was used in the analysis of the variables that are compatible with the normal distribution in intergroup comparison.

RESULTS

Participants consisted of 24 women, 20 males which make 44 university students in total. Age average was 22 ± 1.5 (range: 22-29), academic education time average was 15 ± 1.5 (range: 15-22). Dominant hand was right hand in all participants and none had mental illness in their family history. Two participants had DEHB diagnosis in childhood but they had no medication stories. Musical experience before undergraduate studies of freshman students was 4.72 ± 3.5 years musical experience before undergraduate studies of senior students was 4.43 ± 4.5 . There were no significant difference between two groups in this ($p=0.75$). There were no significant differences in terms of monthly income ($p=0.66$) and DEHB diagnosis in childhood ($p=0.75$). It was also found that there were no significant difference between freshmen and senior students in terms of ASRS-A, ASRS-B and ASRS total points ($p>0.05$) (Table 1).

Senior students completed faster and with fewer

Table 1. Comparison of mean ASRS scores between class groups

| | First class | Fourth class | p |
|------------|-------------|--------------|------|
| ASRS A | 12.00±5.29 | 14.09±4.28 | 0.15 |
| ASRS B | 13.04±4.93 | 14.90±4.73 | 0.20 |
| ASRS total | 25.04±8.40 | 30.50±8.08 | 0.12 |

ASRS: Adult attention deficit and hyperactivity disorder self-reported scale, ASRS A: Attention deficit section, ASRS B: Hyperactivity and impulsivity section

Table 2. Comparison of Stroop Test results between class groups

| | First class | Fourth class | p |
|----------|-------------|--------------|--------|
| Stroop 1 | 18.90±0.67 | 18.11±0.60 | <0.001 |
| Stroop 2 | 26.49±3.57 | 23.00±2.31 | 0.01 |
| Stroop 3 | 33.86±4.51 | 30.56±3.92 | <0.001 |
| Stroop 4 | 63.68±9.69 | 61.29±9.30 | 0.40 |

Stroop 1: Black and white word reading; Stroop 2: Colored word reading; Stroop 3: Saying the box color; Stroop 4: Saying the color of the word

mistakes than freshmen in black and white word reading ($p<0.001$), colorful word reading ($p=0.01$) and saying the colors of the given boxes ($p<0.001$) stages of Stroop test. In the stage of saying the color of the given words, there were no significant difference between two groups ($p=0.04$) (Table 2).

In the results of WMS-R test done to measure working memory activity, it was determined that senior students performed better in the stages of counting months reversely to measure mental control and concentration ($p=0.01$) and counting sevens ($p=0.005$). It was also found that there were no significant differences in the test that measure forward and backward digit span, short and long term verbal and visual recognition and reminder and in the test that measure mental control and concentration ($p>0.05$) (Table 3).

DISCUSSION

Music which is known for its human-specific nature is a functional tool in discovering the ways to depths of the brain. In this study, the effects of music training on attention and working memory with 44 university students of music department were studied. In some stages of the visual Stroop test, it was seen that senior students are

Table 3. Comparison of WMS-R Test results between class groups

| | First class | Fourth class | p |
|-----------------------------|-------------|--------------|-------|
| Digit span (forward) | 7.18±0.95 | 7.45±0.73 | 0.29 |
| Digit span (backward) | 5.00±0.75 | 5.27±0.76 | 0.24 |
| Counting backward (numbers) | 6.09±1.96 | 5.17±1.41 | 0.08 |
| Counting backward (days) | 4.03±0.89 | 3.78±1.02 | 0.39 |
| Counting backward (months) | 15.79±6.09 | 11.12±5.49 | 0.01 |
| Counting by three | 17.17±8.99 | 12.77±4.87 | 0.05 |
| Counting by seven | 52.21±24.04 | 33.45±14.64 | 0.005 |
| Verbal memory (short term) | 9.40±3.52 | 12.27±3.61 | 0.87 |
| Verbal memory (long term) | 9.40±3.52 | 10.40±3.54 | 0.35 |
| Visual memory (short term) | 2.18±0.85 | 2.36±0.58 | 0.41 |
| Visual memory (long term) | 1.95±0.84 | 1.90±0.75 | 0.85 |

WMS-R: Wechsler memory scale revised form

superior to freshmen. However, there was no significant difference at the last stage that measured perception goals. There are limited number of studies about the effects of music on attention. In a study that investigated the effects of averagely 13.9±6.0 years of professional music practice, improvement of attention of those musicians was linked to long term music practice.¹² In another study it was stated that cognitive demand increase related to playing instruments with both hands could improve plasticity and visual attention.¹³ This result made us think that long term music training improved data processing but not for attention. This might be related to the fact that musicians used auditory attention instead of visual attention in our study and they have better skills in this area. Moreover, it is thought that auditory and visual tasks are processed in a multimodal way and changes in adults are possible depending on the stimuli.^{14,15} In a study researching the effects of music experience on adults' executive functions, a similar Stroop test was applied and it was found that musicians performed better than non-musicians.¹⁶ In our study, senior students performed better in some memory tests that measured mental control and concentration than freshmen; however, there were no significant differences in terms of auditory and visual number distance and verbal and visual storage. There were not such differences in terms of music practice before undergraduate studies. Besides music, amount of practice and education might also be effective on attention and memory functions that are actively used during systematic music training. According to the literature, adaptive changes were detected in the musicians who learned to play instruments at a young age. Such changes start at the maturation stage of cerebral

system and they may be playing a role in improvement of other skills.¹⁷ As we know that brain plasticity is induced by experience, the effects of music on a very large area in the brain including fronto-temporo-parieto-occipital areas are very significant. There are studies that found the link between music and verbal tests on phonological area.^{5,18,19} It was found that 8 weeks of music training for pre-schoolers create significant differences on non-verbal IQ, arithmetic and spatial knowledge.²⁰ Improvements in visual short term memory tests were witnessed in children aged between 5 and 6 who take piano training for a year, performance increase was seen in delayed visual recollection and recognition in the adults averagely aged 22.6 and took music training.^{21,22} In a prospective fMRI study, it was suggested that temporary auditory novelties during music training increase processing in hippocampus and hippocampal effects result from music training.²³ A study didn't find significant differences in auditory number distance test as our study, but it linked abilities in cognitive processing of musicians to auditory skills.⁶ It is still not obvious how education types effect improvement of working memory. However, it was already suggested that effects of different types of education that include working memory can be transferred so one task can influence another task. Music training whose transfer effects are known can be beneficial in improving the skills that are activated but not working in convergent areas of the brain.²⁴ Limitedness of the sample group and non-exclusion of the effects of education are the constraints of our study.

CONCLUSION

In our study, it was seen that performance of

some students who took long term music training increased in attention and working memory tests while non-formal music experience made insignificant contributions. This result brought the idea that intensive and systematic music practice

have positive influences on cognition. There is a need for further studies to determine the effects of music on cognitive skills that can be beneficial for many areas from education to medication.

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