

Examining the Impact of Musical Interest on Auditory Processing and Cognitive Skills in Young Adults

Genç Erişkinlerde Müzikal İlginin İşitsel İşleme ve Bilişsel Beceriler Üzerindeki Etkisinin İncelenmesi

 Nuriye YILDIRIM GÖKAY^a,  Gurbet İpek ŞAHİN KAMIŞLI^a

^aGazi University Faculty of Health Science, Department of Audiology, Ankara, Türkiye

ABSTRACT Objective: Music has a complex structure consisting of auditory elements such as sound, rhythm and melody. The ability to perceive, understand and evaluate music is among the auditory skills. This study aims to investigate the effects of musical interest on temporal pattern recognition, auditory processing, and cognitive skills in young adults with normal hearing. **Material and Methods:** The study included sixty volunteer young adults with normal hearing between the ages of 18-30 ages. Young adults were divided into two groups, below (n=30) and above (n=30) average, according to their "Music Interest Scale" scores. "Frequency and Duration Pattern Tests" were applied to evaluate the participants' temporal pattern recognition skills. "STROOP Test" was used to evaluate selective attention, disruptive effect and memory skills among cognitive skills. The findings were analyzed statistically with the SPSS program, and the type 1 error level was determined as 0.05. **Results:** There were significant differences in STROOP subtests in terms of attention skills ($p < 0.05$). On the other hand, no statistically significant difference was obtained between the groups in terms of frequency and duration pattern recognition skills ($p > 0.05$).

Conclusion: Young adults who were interested in music completed tests of selective attention, interference, and short-term memory in less time and performed better. The current study revealed that musical interest in young adults may provide positive effects on these cognitive skills.

Keywords: Auditory perception; cognition; music; young adults

ÖZET Amaç: Müzik; ses, ritim ve melodi gibi işitsel unsurlardan oluşan karmaşık bir yapıya sahiptir. Müziği algılama, anlama ve değerlendirme becerisi işitsel beceriler arasındadır. Bu çalışma, normal işiten genç yetişkinlerde müziğe yönelik ilginin; temporal patern tanıma testleri ile işitsel işleme becerileri üzerine ve dikkat testleri ile bilişsel beceriler üzerine etkileri olup olmadığını araştırmayı amaçlamaktadır. **Gereç ve Yöntemler:** Çalışmaya 18-30 yaşları arasında 60 normal işiten gönüllü genç yetişkin dahil edildi. Genç yetişkinler "Müziğe Yönelik İlgi Ölçeği" skorlarına göre ortalamamın altı (n=30) ve üstü (n=30) olmak üzere iki gruba ayrıldı. Katılımcıların işitsel işleme becerilerinden temporal patern tanıma becerilerini değerlendirmek için "Frekans ve Durasyon Patern Testleri" uygulandı. Bilişsel becerilerden seçici dikkat, bozucu etki ve bellek becerilerini değerlendirmek için "STROOP Testi" kullanıldı. Bulgular SPSS programı ile istatistiksel olarak analiz edilmiş olup, tip 1 hata düzeyi 0.05 olarak belirlendi. **Bulgular:** Müzikle ilgili olan ve olmayan katılımcılar arasında dikkat becerileri açısından STROOP alt testlerinde ($p < 0.05$) anlamlı farklılıklar saptandı. Öte yandan, frekans ve süre patern tanıma becerileri açısından gruplar arasında istatistiksel olarak anlamlı bir fark elde edilmedi ($p > 0.05$). **Sonuç:** Müzikle ilgili olan genç yetişkinler; seçici dikkat, bozucu etki ve kısa süreli bellek testlerini daha kısa sürede tamamladı ve daha iyi performans gösterdi. Mevcut çalışma, genç yetişkinlerde müzik ilgisinin bu bilişsel beceriler üzerinde olumlu etkiler sağlayabileceğini ortaya koydu.

Anahtar Kelimeler: İşitsel algılama; biliş; müzik; genç erişkinler

Music has become an important part of human life, beyond being a form of cultural expression. While the effects of music on emotions are often emphasized, more in-depth research on these effects may help us understand the role of music on individuals' quality of life. In this context, understanding the effects of musical interest level may enable us to un-

derstand how auditory processing and cognitive skills shape these effects.

When people interact with music, auditory processing skills come to the fore. Thus, music has a complex structure consisting of auditory elements such as sound, rhythm and melody. The ability to perceive, understand and evaluate music is among the

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Correspondence: Nuriye YILDIRIM GÖKAY

Gazi University Faculty of Health Science, Department of Audiology, Ankara, Türkiye

E-mail: nuriye.yildirim94@gmail.com

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auditory processing skills.^{1,2} At this point, individuals' auditory processing skills may play a critical role in the process of experiencing the effects of music.¹⁻³

Additionally, the effects of music on cognitive skills are also important. Music can affect cognitive processes such as memory, attention, problem solving and creativity. This interaction can increase individuals' cognitive capacities and support mental functions.^{1,4,5}

Music, auditory processing, and cognitive skills have been studied in all age groups and have been a topic that has attracted the attention of researchers for years. Intervention with computer-based music has been reported to be beneficial for improving auditory processing and working memory skills in older adults.¹ It has been demonstrated that musical training in adults has positive effects on supra-threshold auditory processing in noise, completing sentences, speech perception, and cognitive skills.^{2,6} A review study showed that musical education and musical talent improve auditory processing skills.⁷ Similarly, musical experience improves reading and auditory perception skills in children.^{8,9} Also, musicians' brain networks are shaped differently and have advantages in terms of auditory processing and auditory working memory.⁴ Purposeful or non-purposeful musical activities may be a useful intervention to promote memory consolidation, improved attention skills, and strengthening of neural connections in older adults.^{10,11} Consequently, to understand the effects of musical interest, it is important to address the complex relationship between auditory processing and cognitive skills.

This study aims to examine the effects of musical interest level in the context of auditory processing and cognitive skills and to examine the contributions of this interaction to the general well-being of individuals. Although there are many studies investigating cognition, auditory processing skills, and musical interest, this study differently aims to reveal important findings in young adults with original assessment tools on selective attention and musical questionnaire.⁵⁻⁷ Additionally, suggestions are made about the therapeutic potential of music and how its use in this context may contribute to the development of auditory processing and cognitive skills.

MATERIALS AND METHODS

The current study was ethically approved by the University Ethics Commission with decision number 15. Informed consent forms were obtained from all participants. This study was conducted in accordance with the Principles of the Declaration of Helsinki. The preliminary findings of this study were presented as a summary at the 11th National Audiology and Speech Disorders Congress.

The study included sixty volunteer participants with normal hearing between the ages of 18-30 ages. All participants have a maximum of 20 dB HL at all frequencies (125 Hz-8 kHz) in the pure tone audiometry. Exclusion criteria from the study: hearing loss, previous ear infection/operation, having professional or amateur musical training, playing a musical instrument, and having a history of noise exposure. The young adults were divided into two groups, lower and upper, according to the mean value of their "Music Interest Scale" scores. Participants below the average were defined as uninterested in music group, and participants above the average were defined as interested in music group.

"Music Interest Scale" was developed by Okay H et al.¹² The scale consists of 29 items and is asked to be answered in a 5-point Likert type (strongly agree: 5, agree: 4, undecided: 3, disagree: 2, strongly disagree:1). This scale includes items such as "Watching concerts is one of my greatest pleasures / I wish I were an instrument player/I attend all the concerts held around me/etc." The total score of 29 items was analyzed as the individual's musical interest score. The Kaiser-Meyer-Olkin test result of the scale was determined as 0.899, and the Cronbach's Alpha (α) internal consistency coefficient was determined as 0.918. It is a valid and safe test that determines the level of interest in music.^{12,13}

STROOP Test TBAG form will be used to evaluate selective attention, focused attention and disruptive effect among cognitive skills. Turkish validity and reliability studies of this test were carried out by Karakaş et al., and the reliability coefficient was found to be statistically significant as 0.84 and it was stated that it is a valid test.¹⁴⁻¹⁶ (This test was developed as a TÜBİTAK project. Reference: Karakaş S,

Başar E. Nöropsikolojik değerlendirme araçlarının standardizasyonu nöropsikolojik ölçümlerin elektro-fizyolojik ölçümlerle ilişkileri. Proje No: TÜBİTAK-TBAG. 1993;17(2)) There are five sections in this test. These sections and the relevant cards, in order of application, are as follows: The card with color names printed in black, the card with color names printed in different colors, the card with circles printed in color, the card with neutral words without color names. In the last part, the participant is expected to name the colors of the words on the card with color names printed in different colors. For example; the participant will be asked to read the word “red” written in blue or to say its color. At the same time, the performance time will be determined with a stopwatch.^{14,15} The correct answer scores of the STROOP test and the time to complete the test were analyzed. This test was administered by a single researcher and this researcher has a certificate showing that he/she is qualified to use this test.

Frequency and Duration Pattern tests, which evaluate auditory processing skills, were originally developed by Musiek et al. in 1994.¹⁷ (These tests were used in the studies carried out within the scope of the thesis. Related references: *Tuz D. Erken Dönem Koklear İmplantasyonda Zamansal İşleme Fonksiyonlarının Değerlendirilmesi [Yüksek lisans tezi]. Ankara: Hacettepe, Üniversitesi; 2014. *Yaralı M. Profesyonel müzisyenlerde santral işitsel işleme becerilerinin değerlendirilmesi [Yüksek lisans tezi]. Ankara: Hacettepe Üniversitesi; 2011.*Yurdakul Çınar F. Yarık dudak damak tanılı adolesanlarda işitsel temporal işleme ve konuşmayı anlama becerisinin araştırılması [Yüksek lisans tezi]. İstanbul: İstanbul Üniversitesi-Cerrahpaşa Lisansüstü Eğitim Enstitüsü; 2022.)) In these tests, the participant will be presented with a series of 3 sounds (20 series) (For example, “long-short-long” or “high-high and low”) on 40 dB sensation level through headphones from the computer and will be asked to order the sounds according to their length and thinness.¹⁸ This level was adjusted by cross-checking with a sound level meter whether 40 dB SL could be output from the computer. In the frequency and duration pattern test, each answer in which the participant correctly listed all three sounds was scored as 1.

STATISTICAL ANALYSIS

The findings were analyzed with the IBM SPSS v.24 program, New York, ABD. Whether the findings were normally distributed or not was examined using histogram and analytical methods (Kolmogorov-Smirnov, Shapiro-Wilk tests). For normally distributed data, mean and standard deviation were used as descriptive statistics. Comparisons between groups were tested with Independent Samples t Test, and possible correlations between cognitive skills, music and auditory processing performance were tested with Pearson correlation analysis. The statistical significance level was determined as 0.05.

RESULTS

The study included thirty participants (12 women, 18 men) who were interested in music and thirty participants who were not interested in music, both below and above the mean value of the Music Interest Scale. While the mean value of age in the group interested in music is 21.7 ± 3.68 years, it is 21.93 ± 3.16 years in the group uninterested in music. No statistically significant differences were found between the groups in terms of age and gender. The mean value of the Music Interest Scale was found to be 105.05 ± 19.04 .

All participants had no errors or corrections in the five sub-sections of the STROOP Test. The mean and standard deviation values for the time to complete the sections were presented in Table 1. Accordingly, a statistically significant difference was found between the two groups in terms of completion times in sections 1, 2 and 3 of the STROOP Test. In the group interested in music, the completion times for the first three sections of the STROOP Test were 12.33 ± 1.86 , 12.65 ± 1.44 , and 14.60 ± 1.47 seconds, respectively. In the group that were uninterested in music, 14.10 ± 1.97 seconds, 14.58 ± 2.11 and 15.74 ± 1.40 seconds. According to the scale, volunteers who were interested in music performed better in the first three sections of the STROOP test. On the other hand, no statistically significant differences were found between the groups in the 4th and 5th sections of the STROOP test.

The results of frequency and duration pattern tests to assess auditory processing skills were pre-

TABLE 1: Completion time of STROOP test by interested in music and uninterested in music groups.

Completion time of STROOP test (second)/groups	Uninterested in music	Interested in music	p value
	$\bar{X}\pm SD$	$\bar{X}\pm SD$	
STROOP1	14.10±1.97	12.33±1.86	0.001*
STROOP2	14.58±2.11	12.65±1.44	0.001*
STROOP3	15.74±1.40	14.60±1.47	0.003*
STROOP4	22.15±3.80	21.72±2.51	0.613
STROOP5	25.86±3.25	25.12±2.97	0.361

*There is a statistically significant difference; SD: Standard deviation.

TABLE 2: The correct scores of pattern tests by interested in music and uninterested in music groups.

The correct scores of pattern tests/groups	Uninterested in music	Interested in music	p value
	$\bar{X}\pm SD$	$\bar{X}\pm SD$	
Frequency pattern test	18.50±1.11	18.90±1.06	0.158
Duration pattern test	18.57±0.86	18.77±0.97	0.402

SD: Standard deviation.

sented in Table 2. While those who were interested in music had 18.90±1.06 correct answers out of 20 stimuli, those who were not interested in music had 18.50±1.11 correct answers. Accordingly, no statistically significant differences were found between groups with and without interest in music in terms of frequency and duration pattern recognition skills.

No statistically significant correlations were found between frequency and duration pattern recognition scores and STROOP test completion times (Table 3).

DISCUSSION

This research was conducted to examine the potential effects of young adults’ musical interest level on auditory processing and cognitive skills. The current findings provide important clues in revealing young adults’ interest in music. This discussion section includes important issues that will highlight the general meaning of these findings and shed light on future research.

Many research shows that engaging with music positively impacts young adults’ quality of life. It has been observed that music is a factor that increases people’s emotional wellness, social relationships, and general life satisfaction. In this context, the positive

TABLE 3: Correlations between temporal pattern recognition scores and STROOP completion times.

		FPT	DPT
		STROOP1	r
	p value	0.482	0.984
	n	60	60
STROOP2	r	-0.180	0.061
	p value	0.170	0.645
	n	60	60
STROOP3	r	-0.149	0.134
	p value	0.255	0.306
	n	60	60
STROOP4	r	-0.248	0.102
	p value	0.056	0.439
	n	60	60
STROOP5	r	-0.220	0.064
	p value	0.092	0.627
	n	60	60

r: Pearson correlation; FPT: Frequency pattern test; DPT: Duration pattern test.

effects of music on quality of life have the potential to support the psychosocial well-being of young adults.¹⁹⁻²² Differently, the current study revealed young adults’ interest in music and linked it with hearing and some cognitive skills.

A study by Tichko et al. revealed that auditory processing, reading subskills, and musical experience are related in adulthood. The same study found that

faster neural conduction times and stronger rapid naming skills were related to more musical experience.²³ Another study found that, unlike musical interest, musical training can cause stimulus-specific brain changes in school-age children.²⁴ Also, it has been stated that musical training in young adults improves structural and functional auditory motor neural networks and selective auditory attention.^{25,26} Although there are important findings that music can improve auditory processing skills, no significant differences in auditory processing skills were detected in the current study.^{7,28,29} This may be due to the use of only scales as a measurement tool. Another possible reason may be that auditory processing skills other than temporal pattern recognition ability may be affected. One of the possible reasons is that the hearing thresholds of all participants were 20 dB HL and better. Future studies that include cross-control with people with hearing loss may be useful. Differently, this study evaluated temporal processing skills in young adults with frequency and duration pattern tests. Finally, it is known that young adults who are exposed to music have an increased ability to better understand and interpret their auditory perceptions.^{23,27}

This study showed that music can also have a significant impact on some cognitive skills. The findings showed that young adults who were interested in music performed better in selective attention, Stroop effect and short-term memory skills. Young adults who were interested in music completed STROOP tests significantly earlier. It has been determined that young adults who are interested in music experience an increase in their cognitive functions and positive changes are observed, especially in their memory, attention and problem-solving abilities. As a matter of fact, the STROOP test evaluated selective attention, focused attention and disruptive effect. Thus, these findings suggest that music may support cognitive development and strengthen the mental abilities of young adults. Additionally, similar results were obtained in studies involving other cognitive tests.^{29,30} It has been determined that musical interest has a role on executive functions in young adults.³¹ A relationship has been found between singing and/or playing a musical instrument and cognitive functions in older adults.³² Also, it has been re-

vealed that there are differences between adults and children in terms of music-related cognitive skills and emotions.³² Conversely, there were no statistically significant differences between musical and non-musical young adults in STROOP 4 and 5 tests in his study. Since the STROOP test must be performed in accordance with the step-by-step order, obtaining no significant differences in these last sections may be due to the test learning effect. Differently, the current study tested the effect of selective attention and short-term memory in young adults with the STROOP test and related it to music and auditory processing. To the best of the authors' knowledge, no studies have been found that combine the STROOP test, musical interest, and temporal pattern tests in young adults.³³⁻³⁵ In this respect, it is thought that this study will attract the attention of experts working in the field.

Music can have positive effects on young adults' auditory processing and cognitive skills. However, it is important to conduct future studies with larger sample groups and long-term follow-ups. Additionally, more comprehensive research that includes cultural and social factors is needed to examine the effects of different types of music and interest levels, to develop more specific tools for measuring the interest of music, and to understand how music varies among individuals.

CONCLUSION

This research has shown that music can provide positive effects on auditory performance and attention & memory skills in young adults with normal hearing. These findings highlight the potential for music to support the specific areas and the importance of research on music-related hearing and cognition performance.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or mem-

bers of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Nuriye Yıldırım Gökay; **Design:** Nuriye Yıldırım Gökay; **Control/Supervision:** Nuriye Yıldırım Gökay, Gubet İpek

Şahin Kamışlı; **Data Collection and/or Processing:** Nuriye Yıldırım Gökay, Gubet İpek Şahin Kamışlı; **Analysis and/or Interpretation:** Nuriye Yıldırım Gökay, Gubet İpek Şahin Kamışlı; **Literature Review:** Nuriye Yıldırım Gökay, Gubet İpek Şahin Kamışlı; **Writing the Article:** Nuriye Yıldırım Gökay; **Critical Review:** Nuriye Yıldırım Gökay; **References and Fundings:** Nuriye Yıldırım Gökay.

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