The Effects of Listening to Music with Vocals and without Vocals on Typing Performance of Younger and Older Adults

Nilay Usta

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Assoc. Prof. Dr. Ali Hakan Ulusoy
Acting Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Developmental Psychology.

Assoc. Prof. Dr. Şenel Hüsnü Raman
Chair, Department of Psychology

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Developmental Psychology.

Asst. Prof. Dr. İlmiye Seçer
Co-supervisor

Asst. Prof. Dr. Çığır Kalfaoğlu
Supervisor

Examining Committee

1. Assoc. Prof. Dr. Fatih Bayraktar
2. Assoc. Prof. Dr. Şenel Hüsnü Raman
3. Asst. Prof. Dr. Çığır Kalfaoğlu

ABSTRACT

Typing has become a widespread necessity in education, work and everyday life, making it worth investigating factors that impact it. Therefore, the objective of the current study was to examine the effects of listening to music with and without vocals on typing performance, and how this effect increase or decrease with age. A total of 60 Turkish speaking participants who were either younger (*n* = 30) or older than 40 years of age (*n* = 30) were recruited for the current study. One was excluded from the analysis because of his/her outlying performance. Typing performance score (TPS) of participants was measured under three music conditions (no music, music with vocals, and music without vocals). Participants were required to type Turkish words presented on a computer screen. Results showed that participants', TPS decreased when they listened to music (with and without vocals), however, there were no differences in TPS between the conditions with music (i.e., with and without vocals). In addition, results showed that the effect of listening to music on TPS didn't interact with age. Implications such as the development of executive functioning in older adults and the importance of typing in the educational and employment setting were discussed.

Keywords: Age, Executive Functioning, Listening to music, Typing process

ÖZ

Klavye ile yazım; eğitim hayatında, iş hayatında ve gündelik hayatta yaygın bir gereklilik haline gelmiştir. Bu nedenle klavye ile yazım performansına etkisi olabilecek faktörlerin (müzik dinlemek ve yaş) araştırılması önem kazanmıştır. Mevcut çalışmada, sözlü ve sözsüz müzik dinlemenin klavyede yazım performansı üzerine etkisi ve bu etkinin yaşla birlikte artıp artmadığının araştırılması amaçlanmıştır. Çalışmada Türkçe konuşan 40 yaş altı, daha genç grup (n = 30) ve 40 yaş üstü, daha yaşlı grup (n = 30) olmak üzere toplam 60 katılımcı yer almıştır. Genç gruptaki katılımcılardan birinin klavye ile yazım performansı genel dağılımdan farklı olduğu için analizlere dahil edilmemiştir. Katılımcılardan ekranda gördükleri Türkçe kelimeleri 3 farklı müzik koşulunda (müzik olmadan, sözlü müzik eşliğinde ve sözsüz müzik eşliğinde) yazmaları istenmiştir. Sonuç olarak, katılımcıların klavye ile yazım performansının müzik (sözlü ve sözsüz) eşliğinde azaldığı bulunmuştur. Ancak iki koşul arasında (sözlü ve sözsüz müzik) anlamlı bir fark ortaya çıkmamıştır. Ayrıca sonuçlar, klavyede yazım performansı üzerine müzik dinleme ve yaşın anlamlı bir etkileşiminin olmadığını göstermektedir. Çalışmada, eğitim ve iş alanlarında klavye ile yazım performansının önemi ve yaşlı bireylerin yönetici işlev performanslarını nasıl geliştirebileceği tartışılmıştır.

Anahtar Kelimeler: Klavye ile yazım, Müzik dinleme, Yaş, Yönetici İşlev

To My Family

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LIST OF SYMBOLS AND ABBREVIATIONS

ANOVA	Analysis of Variance
dBA	Threshold of human hearing
e.g.	Example given
et al.	And others
etc	Et cetera
F	F-ratio
IKI	Inter-key-press Interval
i.e.	That is
M	Mean
mm	Millimeters
ms	Milliseconds
n	Sample size
p	Probability
r	Pearson’s Correlation Coefficient
SD	Standard Deviation
SPSS	Statistical Package for Social Science
t	Critical Value
TPS	Typing Performance Score
wpm	Word per minute
>	Greater than
<	Smaller than
η2	Eta-squared (a measure of the size of an effect)

Chapter 1

INTRODUCTION

The typewriter, a form of modern technology, initially invented in 1868 by Christopher Latham Scholes allowed for clear, legible, and uniform written documents (Condoor, 2004). Today, the typewriter has evolved into the present day computer-keyboard, also used as a form of communication, wherein the importance given to the typing process is increasing in society that is in the education system, workplace, and simply everyday life (Czaja et al., 2006). For example, while schools require students to submit their homework typed rather than handwritten (Mogey, Paterson, Burk & Purcell, 2010), in everyday life, interpersonal communications are undertaken by online communication on social media platforms such as facebook, twitter, and blogs that include diary-style typed text entries via a computer (Wood & Smith, 2004). Likewise, in the workplace, typing skill is considered an important personal skill, which can increase work efficiency, hence, is a considerable feature of the recruitment phase (Robles, 2012). Since retaining a certain level of typing skill and performance is important in a number of contexts (e.g., schools, workplace, and everyday life), it is crucial to investigate how this process can be hindered or facilitated to allow individuals the opportunity of optimal functioning in their daily lives.

Typing, a skilled action that includes both motor and cognitive processes and requires executive functions and cognitive expertise to be executed (Kalfaoğlu &

Stafford, 2014), is considered one of the most complex and effortful activities that humans engage in (Logan & Crump, 2011). The need for executive functions and cognitive expertise makes typing a complex task because both cognitive (i.e., attentional control, inhibitory control, working memory, language comprehension or expression) and motor (i.e. programming and coordinating fast finger movements) processes are required to type accurately (Salthouse, 1986). The process of typing becomes even more complex when an individual undertakes a concurrent activity such as listening to music while typing since executing tasks such as typing and listening to music each requires a certain amount of mental resources (Craik & Byrd, 1982). When the amount of cognitive and motor effort required to complete two tasks is greater than that required to complete one of those tasks, insufficient cognitive resources are available for the execution and completion of each task (e.g., typing), which leads to a decrease in task performance (Craik & Byrd, 1982). Typing performance could thus be spared for individuals who retain better capacity to allocate their attentional resources among multiple tasks (Ransdell & Gilroy, 2001).

For the effective performance of multiple tasks, it is important for an individual to practise performing those tasks (Ericsson & Krampe, 1993). This is because practise allows for parallel processing to develop which does not require much attentional resource for tasks to be performed concurrently (Schneider & Shiffrin, 1977). On the contrary, when tasks are not practised they require greater amount of attentional resources that make it difficult for them to be performed together (Schneider & Shiffrin, 1977).

In addition to the availability of cognitive resources, performing multiple tasks is further negatively affected by one’s age: older adults have been found to have poorer performance in executing multiple tasks compared to younger adults (Cabeza & Dennis, 2012). The effect of age on dual task performance is in line with the frontal lobe hypothesis of cognitive aging (Dempster, 1992; Haug & Eggers, 1991; West, 1996). This hypothesis suggests that executive functions (e.g., working memory, inhibiting irrelevant information) are mediated largely by the frontal regions of the brain (specifically the prefrontal cortex), and decline with increasing age. Age related degenerations in the prefrontal lobes have been shown to start earlier (i.e., in the 4th decade of life, before age 50) than other parts of the brain such as the occipital lobe (which begins to decline between the ages of 60 to 65 years, Haug & Eggers, 1991). It is therefore expected that age would impact typing performance under dual task conditions (i.e., performing a typing task while concurrently listening to music) compared to single task conditions (i.e., only performing a typing task).

In the current study, typing was used as an experimental paradigm to understand how cognitive processes associated with frontal lobe functions such as cognitive capacity is affected by normal aging. An objective of the current thesis was to therefore examine the effects of listening to music with versus without vocals on typing performance of younger and older adults to better understand how age affects cognitive capacity. To better understand the proposed interaction between typing, cognitive capacity, and aging, the following sections will present information on the factors' that impact typing performance and theoretical background of cognitive aging.

1.1 Models of Attention

There are three types of models of attention closely related to the current study, which were derived from the capacity model of attention (Kahneman, 1973). These are the attentional resource theory (Craik, 1983), reduced attentional resource theory (Craik & Byrd, 1982) and multiple resource theory (Wickens, 1984). According to the capacity models (Kahneman, 1973), people have a certain amount of capacity that is allocated to the performance of more than one concurrent task. Attentional resource theory in particular assumes that attentional resources are allocated to tasks from a single pool of resources and that after resources are devoted to the primary task the remaining resources are allocated to the performance of the secondary task. If the cognitive demands of the two tasks do not exceed the capacity of the individual, both tasks can be performed together successfully (i.e., without a decrease in performance). However, if the cognitive demands of the two tasks exceed the capacity of the individual a decrease in either one or both tasks occurs. Multiple task performance is thus dependent on the capacity of an individual. Based on these findings, it is expected that when an individual concurrently deals with a secondary task such as listening to music while typing (i.e., primary task), both tasks demand more attentional resources together than single task. This exceeds the capacity of an individual and so, typing performance will decrease. Furthermore, according to the reduced attentional resource theory (Craik & Byrd, 1982) one's available amount of attentional resources decreases as one gets older. Older adults compared to younger adults therefore are more likely to have difficulty in performing concurrent tasks (i.e., typing and listening to music).

Unlike the notion of a single pool of resources, the multiple resource theory (Wickens, 2002) states that there are separate pools of resources for each type of task (e.g., verbal, visual, motor). Therefore, if the two tasks require resources from the same pool and if the demand of the two tasks exceeds that of the individual then task performance will decrease (Wickens, 2002). However, if the two tasks to be performed require resources from different resource pools and if the demand for each task does not exceed the capacity of the individual then dual task performance is effectively performed (Wickens, 2002). Based on these findings, the current study expected that typing performance will be affected by listening to music, especially with vocals since both typing and vocal music demand resources from the same pool of resources (i.e., phonological).

1.2 Cognitive Aging

There is a wide range of literature (Glisky, 2007; Haug and Eggers, 1991; Schaie, 2005; West, 1996) on age related decline in concern with cognitive processes (i.e., attention, memory, motor skills and executive functioning) and that literature reported various findings on the age of onset of performance decline for the different types of tasks. According to Schaie's (2005) Seattle longitudinal study which was operated continuously with 7 year intervals to find intraindividual changes over 49 years, participants were tested on six different types of cognitive ability (i.e., spatial orientation, inductive reasoning, verbal comprehension, numerical ability, perceptual speed and verbal memory). Results showed that adults start having difficulty in solving basic numerical problems and understanding the visual tasks after the age of 60, and reduction in ability to visualize spatial configurations, problem solving and recalling the language units start to be observed after the age of 67. Reduction in ability to understand the meaning of the expressed words start to be observed after the age of 81 (Schaie, 1996). This set of results show cognitive decline is not observed prior to the 6^{th} decade of life (Schaie, Maitland, Willis & Intrieri, 1998).

On the other hand, cross sectional analyses, which are more sensitive to differences due to cohort effects compared to longitudinal studies, were made by using the data of Seattle longitudinal study to find interindividual age differences on cognitive processes (Schaie & Strother, 1968). Results showed that performance of numeric ability and verbal comprehension remains stable until the age of 60, and after that starts to decline. Further, performance of spatial orientation, perceptual speed and inductive reasoning starts to decline at the age of 46 and performance of verbal memory starts to decline at the age of 39 years (Schaie, 2005) which is in line with the Haug and Eggers's (1991) neuroimaging and morphological studies that is explained in detail in the following section suggested that the ability to effectively perform on the task becomes more challenging after the age of 40.

1.2.1 Frontal Lobe Hypothesis of Cognitive Aging

The prefrontal cortex of the brain, which is important for a number of mental processes including working memory, attention, and executive control (Miller & Cohen, 2001) and is shown to be important for performing two tasks at the same time (Esposito, Detre, Alsop & Shin, 1995; Johannsen et al., 1997), reaches maturation at a later time than other regions of the brain such as the cerebellum (Arain et al., 2013). The frontal lobe hypothesis of cognitive aging (Haug & Eggers, 1991; West, 1996), is based on the neuroimaging and morphological studies that show the negative effects of age such as cell death and shrinkage are more pronounced and have an earlier onset in the frontal regions compared to other regions of the brain. Indeed, cognitive functions off the prefrontal cortex (i.e., executive control, working memory, and attention) starts to decline in the 4th decade of life (at the age of 40), which is earlier than other brain regions (i.e., occipital lobe) (Haug & Eggers, 1991). Other studies further confirm age related functional deteriorations of the prefrontal cortex, especially the dorsolateral prefrontal cortex (dlPFC, Dempster, 1992; Raz, 2000; West, 1996), that is related to older adult's greater difficulty in performing more than one task concurrently (Kane & Engle, 2002). Based on these findings, it is expected that younger adults who have more efficient functioning of the prefrontal cortex than older adults are able to divide their attention among multiple tasks more efficiently, thereby have enhanced multitasking abilities. This theoretical framework provides a basis for any decline that may be observed in dual task performance by individuals older than 40 years of age.

1.3 Hierarchical Control Theory of Typing

Typing involves concurrent perceptual, cognitive and motor processes including language (i.e., reading, comprehension, word generation), conversion of semantic and perceptual units of information (i.e. sentences, words, letters) into motor commands, very quick and highly coordinated execution of these commands by the fingers, in addition to continuously checking the compatibility of performance with the expected outcome (Salthouse, 1986; Crump & Logan, 2010). Logan and Crump (2011) developed the hierarchical control theory of typing to account for how these processes might be interacting to in order to achieve typing. Even though none of the hypotheses which are tested in the current study are directly related to its predictions, it is important to introduce this influential theory of typing since the experimental paradigm used to test the hypotheses of the current study is typing. Further it provides a theoretical framework to interpret the findings with respect to cognitive processes.

According to Logan and Crump (2011), complex tasks such as typing can be controlled hierarchically by two nested loops: outer and inner loops. The *outer loop* serves to generate a series of words through language comprehension in reading (or word generation when composing) and then pass these words one by one to the *inner loop.* The inner loop takes each word and translates it into a series of letters, and converts these letters into series of key-presses to be executed on the keyboard. According to these authors, outer loop is involved in higher level cognitive processes and commands the inner loop to type words, which is involved in selection, coordination and execution of necessary finger presses.

There are a number of important characteristics of the Hierarchical Control Theory (Logan & Crump, 2011). First, Logan (2003) claimed that information transfer from the outer loop to the inner loop takes place at the word level. That is, it is typically not single letters or larger phrases, but words that are sent from the outer loop to the inner loop (Logan & Crump, 2011). While typing, the outer loop knows which word is being typed, but it doesn't know which letter is being typed by which finger (Logan & Crump, 2009). Second, the feedback available to the inner loop is different from the feedback available to the outer loop. Outer loop relies on the visual feedback on the screen while the inner loop relies on the somatosensory feedback from the fingers (Crump & Logan, 2010).

1.3.1 Factors that Impact Typing Performance

Typing performance, measured in terms of typing speed and accuracy, has been shown to be influenced by factors such as computer related issues (i.e., the keyboards' design, type & size) (Brunner & Richardson, 1984; Madison et al., 2015; Sears, Revis, Swatski, Crittenden & Shneiderman, 1993; Van Galen, Liesker & de Haan, 2007), background sounds (i.e., noise & speech), and individual differences (i.e., practice, linguistic ability, & age) (Furnham & Strbac, 2002; Salthouse, 1984; Sterns & Miklos, 1995).

With regard to background sounds (e.g. speech & noise), past research (Jiang & Sengupta, 2011; Ransdell & Gilroy, 2001; Ransdell, Levy & Kellogg, 2002; Ryherd & Wang, 2008) has shown that being exposed to background sounds while typing impacts typing performance such that it decreases speed and accuracy. Using the Six-Subgroup Quality Scale, Ransdell et al. (2002) examined participants' essay typing fluency and quality and typing speed, in two conditions: while there was no background speech or while participants listened to background speech. Results showed that participants typed more slowly under the background speech condition (14 wpm) compared to the no background speech condition (17 wpm), yet, background speech had no reliable effect on writing quality. Likewise, Ryherd and Wang (2008) found that participants' typing speed under the indoor annoying noise condition compared to the no noise condition significantly decreased. These studies as a whole suggest that background sounds (i.e., speech & noise) detrimentally affect typing performance.

Individual differences in skill are an additional factor that has received considerable interest in the typing literature (Drake & Palmer, 2000; Liu, Crump & Logan, 2010). The term "skill" generally refers to expertise in some tasks (i.e., typing, playing the piano, driving) and skilled performance in tasks thus develops *over practice* (Yamaguchi & Logan, 2014). Skilled typists who have more practice type quicker than novice typists who have less practice in typing (Drake & Palmer, 2000; Liu et al., 2010; Yamaguchi & Logan, 2014). Linguistic ability, that is, using and understanding language, has further been found to influence one's ability to type accurately and fast (Cohen & Wicklund, 1990). For instance, Salthouse (1984) found that repetition of words via typing and speech leads to an increase in one's typing speed. On the other hand, much research (Bherer et al., 2005; Cherry & LeCompte, 1999; Reese & Cherry, 2002) on the comparison between younger and older adults' task performance showed that older adults' performance such as memory monitoring, reading comprehension, and attentional control was worse than younger adults' performance due to the normal aging process of the brain. Given that age is an influential factor that affects cognitive and motor performance for a number of activities, including typing (Bosman, 1993; Salthouse, 1984), the following section will expand on the effects of age on typing performance.

1.3.1.1 Effects of Age on Typing Performance

Although the extant literature documents that age is an important factor that can impact upon task performance such as reading comprehension (Borella, Carretti, Riboldi & De Beni, 2010), memory monitoring (Cherry & LeCompte, 1999), attentional control (Bherer et al., 2005), and dual task performance (Anderson et al., 1998; Glisky, 2007), fewer studies (Bosman, 1993; Salthouse, 1984) have compared typing performance between young and old adults. To the best of our knowledge, no study has examined the effects of age on typing performance under dual task conditions (i.e., typing while listening to music). Considering that individuals may engage in typing while they listen to music, which creates a divided attention condition that is detrimentally affected by older age (Anderson et al., 1998), The current study thus aimed to determine how age might influence typing performance under dual conditions.

Of the studies that have examined age-related changes on typing performance (i.e., typing speed and keystrokes' accuracy), Salthouse (1984) conducted a study with skilled and novice typists whose age ranged from 19 to 72 years. Typists were required to complete tasks such as typing a paragraph taken from a book or typing words that were displayed on a video monitor. Results showed that as age increases typists had poor performance on rate of tapping, digit-symbol substitution rate, and perceptual-motor efficiency (i.e., a choice reaction time task) however, no statistically significant reduction in typing speed was found with increasing age. Salthouse (1984) suggested that the non-significant findings with regard to age could be because older adults may have maintained their typing performance over the years due to having more practice in typing as skilled typists than the younger adults, who were also skilled typists. As participants got older their probability of making transposition errors (i.e., when the letters of a word are written in the incorrect order) decreased. This suggests that older adults might have more precise control on sequencing of keystrokes than younger adults. Overall, the findings of Salthouse (1984) indicate that while for some measures of typing (i.e., typing speed) age-related differences may not exist, certain types of errors (such as transpositions) become less frequent in older age. Further research is however warranted to clarify the effect of age on typing performance, under both single task and dual task conditions.

1.3.1.2 Effects of Listening to Music on Typing Performance

In light of research findings which reveal that individuals concurrently engage in listening to music while typing (Wickens, 2002; Ralph, Thomson, Cheyne & Smilek, 2014) and that performing two activities at once can affect performance on both tasks (Craik et al., 1996), few studies (Cho, 2015; Jensen, 1931; Jiang & Sengupta, 2011; Ransdell & Gilroy, 2001) have investigated the effects of listening to music on typing performance in terms of typing speed and accuracy. Such research is crucial as it can illustrate the conditions under which, for example, students' school performance and essay writing can be negatively or in some cases even positively affected, and suggest ways in which individuals' typing performance can be enhanced.

To the best of our knowledge, one of the earliest studies investigating the effects of listening to music on typing performance was that of Jensen (1931), which examined younger adults' typing speed and accuracy under three conditions: no music condition, a jazz music condition, and a dirge music condition. All participants were given typing training sessions across three weeks in order to equalise their typing ability before the experimental sessions began. Participants' typing speed (wpm) and their typing accuracy (the number of errors they made in typing the words per minute) had been measured. The results of this study showed that the number of words that could be typed per minute statistically decreased in the jazz music condition compared to the dirge and no music conditions, while the number of keystrokes per minute significantly decreased in the dirge music condition compared to the jazz and no music condition. Furthermore, results showed that the number of errors made per minute significantly increased in the jazz music condition compared to the no music condition. These findings suggest that the no music condition is the optimal condition for a typing activity, while listening to music can have serious detrimental effects on typing speed and accuracy and that the number of words, keystrokes, and errors performed per minute differs according to the type of music (e.g., dirge music vs. jazz music).

Similarly, Ransdell and Gilroy (2001) compared college students' word processing (typing) performance while they either listened to music or not. College students with an average typing speed of 35 wpm were recruited and tested for their typing performance under four conditions (i.e., no music, vocals only, music with vocals only, and vocal and music with vocals combined). For all four conditions, participants typed essays for 10 minutes, which allowed for the examination of their typing performance in terms of writing fluency and quality, average sentence length, number of times the participants paused while typing, and where in the text these pauses happened (e.g., at the beginning to new sentence). For the instrumental and vocal conditions, versions of the song ‘The More I See You’ was used, while for the instrumental and vocal combined condition the song ‘I Had the Craziest Dream’ was used. Both these songs were classified as slow ballads and were similar in terms of length, tempo, content, and volume. Findings of the study revealed no significant differences in typing performance between the vocal music, music with vocals and the vocal and instrumental combined conditions. On the other hand, when the music conditions (i.e., vocal music, music with vocals and combined) were collapsed, a significant difference in typing performance between the no music and the music condition emerged. It was found that participants did not type their essays as effectively as was done in the no music condition which suggested that listening to slow tempo music while typing caused significant cognitive load, which thus reduced younger adult’s typing performance (i.e., fluency and quality) in one’s native language.

The detrimental effects of background music on typing performance has further been illustrated by the findings of Jiang and Sengupta (2011), who found that music significantly reduced the number of correct key strokes pressed on a keyboard. In a similar fashion, Cho (2015) examined the effects of listening to music on typing performance, yet in one’s second rather than native language. For this study, 28 university students whose native language was Korean and second language was English (as determined by their Test of English for International Communication (TOEIC) scores that varied between 670 to 990) were recruited to test their typing performance in the English language under two conditions (i.e., a music condition and a no music condition). For this study, one of the most popular fast-paced Korean songs, Gangnam Style, was chosen as the song in the music condition. For both conditions (i.e., the no music and music condition), all participants typed argumentative essays for a period of 30 minutes, which was used to examine their writing fluency and quality. Results of this study showed that the number of pauses made between writing the words were less in the music condition compared to the no music condition, however, there were no significant differences between the two groups in terms of typing fluency and quality. Cho (2015) explained that fast-paced music resulted in lower levels of tension and anxiety while typing; therefore participants' typing performance in terms of frequency of pauses was enhanced due to concurrently listening to music. In sum, the findings of Cho (2015) illustrate some positive effects of listening to music on typing performance in one's second language.

Overall, findings of past studies with regards to the effects of background music on typing performance is varied, while some studies (e.g., Cho, 2015) find beneficial effects of music on typing performance, others show a detrimental effect (e.g., Jensen, 1931; Jiang & Sengupta, 2011; Ransdell & Gilroy, 2001). Such discrepancies in findings of past studies (i.e., Cho, 2015; Jensen, 1931) could be attributed to a number of factors such as the pace/tempo of the music, in which slow music such as dirge music compared to fast paced music has been shown to lead to a greater number of errors in typing. Given the mixed findings, it is therefore important to further examine the effects of music on typing performance.

1.4 Current Study

The literature documents that typing is a complex process that requires executive functions which are heavily dependent on the activity of the frontal lobe (Stuss & Knight, 2002). In addition, when an individual concurrently deals with another task such as listening to music while typing, the need for executive functions increases, attentional resources need to be allocated among these tasks, and since each task requires a certain amount of cognitive resources, performance on these tasks decreases (Craik & Byrd, 1982). In line with past studies (i.e., Cho, 2015; Ransdell & Gilroy, 2001) that have examined typing performance under dual task condition, the present study primarily aimed to investigate the effects of listening to music on individuals' typing performance by manipulating the music conditions (i.e., no music, music with vocals and music without vocals). Secondly, the present study aimed to investigate the differences between music conditions (i.e., music with vocals and without vocals) based on the multiple resource theory which indicates that when concurrent tasks require resources (i.e., verbal) from the same pool rather than a different pool, task performance reduction occurs (Wickens, 2002). Typing and listening to music with vocals require attentional resources from the same pool of resources (i.e., phonological,Wickens 2002) than when typing is performed with music without vocals (i.e., the instrumental music condition). Therefore, it is expected that music will disrupt typing performance more during the music with vocals condition then the instrumental music condition.

One of the important theories used to guide the hypotheses in the current study is the frontal lobe hypothesis of cognitive aging which states that the prefrontal cortex (and the mental processes subserved by them) deteriorates earlier and to a greater extent than other brain parts as one becomes older (Dempster, 1992; West, 1996). For instance, Cabeza and Dennis (2012) suggest that older individuals show poor performance on dual tasks compared to younger individuals. Further, age-related differences might contribute to typing performance that has been unstudied in previous studies examining the effects of background music on typing performance (i.e., Jensen, 1931; Cho, 2015; Ransdell & Gilroy, 2001, see section 1.2.1.1). This has therefore limited any comparison between different age groups (i.e., younger vs. older adults) on typing performance while listening to music. An objective of the current study was to compare the performance of younger participants to older participants under different music conditions and discuss the findings from a developmental psychology perspective.

1.4.1 Hypotheses

Hypothesis 1: Based on the attentional resource theory, listening to music (with and without vocals) will lead to a reduction in typing performance.

Hypothesis 2: Based on the multiple resource theory, typing performance will decrease under the music with vocals compared to the music without vocals (instrumental) condition.

Hypothesis 3: Based on the frontal lobe hypothesis of cognitive aging, older adults will have poorer typing performance compared to younger adults.

Hypothesis 4: Based on the frontal lobe hypothesis of cognitive aging, reduction in typing performance due to music will be stronger in older adults than in younger adults.

Chapter 2

METHODS

2.1 Participants

The convenience sampling method and snowball technique were used to recruit a total of 60 younger and older Turkish speaking participants from different locations in Northern Cyprus. In line with the neuroimaging and morphological findings of Haug and Eggers (1991), an age of 40 was used as a cutoff point to form the two age groups, thus participants in the current study were either younger than 40 years or older than 40 years of age. The age range of younger participants were between 18 and 35 (*M* = 24.13, *SD* = 4.38) and the age range of older participants were between 43 and 66 (*M* = 50.20, *SD* = 5.87). The native language of all participants was Turkish; all had normal or corrected-to-normal vision, were not professional touch typists, and did not play any instruments in their daily life.

2.2 Design

The current study was of an experimental design that aimed to measure participants' typing performance under three different music conditions across younger and older adults. There were two independent variables; age (< 40 and > 40) and listening to music (no music condition, music with vocal condition and music without vocal condition). The order of the three music conditions was counterbalanced across participants to minimize order effects. The dependent variable to represent typing performance was calculated by dividing the accuracy (1 - Error rate) by the average inter-key-press-interval (IKI) of the participant. IKI is the time elapsed between consecutive keystrokes. Please see section **2.5** for more details about how IKI was calculated.

2.3 Materials

2.3.1 Controlled Oral Word Association Test (COWAT)

The Controlled Oral Word Association Test (COWAT, see Appendix A), developed by Benton (1969), is a subscale from the Multilingual Aphasia Examination, commonly used to test verbal fluency. For this test, two different letter sets (i.e., C-F-L and P-R-W) are presented to participants and their task is to generate as many words as possible (excluding special names and place names such as Robert, Canada etc.) in one minute for each letter. The total number of words generated across the three letters in one minute is evaluated. Unacceptable responses such as writing special names, repetition of the same word, and non-meaningful words do not count while calculating the total score. The COWAT has been adapted to Turkish language by Umaç (1997) wherein the letters K, A and S letters were used. The current study used the Turkish adaptation of the COWAT to ensure that age groups were matched on the level of verbal fluency in the Turkish language.

2.3.2 Experimental Typing Tasks

An experimental typing task was used to test participants' typing ability under three different conditions: i) When there is no music, ii) when there is music with vocals, and iii) when there is music without vocals. For this task, a personal laptop computer running windows 8 with a 15.6 inch monitor and a standard QWERTY keyboard was used. In order to present visual stimuli and to collect typing data, MATLAB © 2009 Psychtoolbox software (Brainard, 1997; Pelli, 1997; Kleiner et al, 2007) was used. In line with those of other typing studies (e.g.,Yamaguchi, Crump & Logan, 2013), the visual stimuli included 150 Turkish words (see Appendix C) that were five letters long and were selected from the Turkish version of the book *The Little Prince* (Yılmaz, 2016). Only the words which consisted of 5 letters and contained latin alphabet letters (no "ı","ş","ğ","ü","ö","ç" letters) were used. Words were presented in black on a white screen, with 50 font in Arial typeface. Custom scripts written in MATLAB © was used to record the status of the keyboard every other millisecond so that each key-press and its corresponding time can be recorded. Demographic information such as participants' age, gender, handedness, and employment status was also recorded through MATLAB ©. In addition, Apple Iphone 5 was used to present auditory stimuli which were songs with and without vocals (instrumental).

2.3.3 Choice of Music / Song

In line with previous research (Abril & Flowers, 2007; Pereira, Teixeira, Figueiredo, Xavier, Castro, & Brattico, 2011), a popular pop song was used as auditory stimuli and presented using headphones attached to the iphone. As long as participants did not ask to adjust the volume, the volume of the music was 104.0 dBA. The chosen pop song was "Aşk mı Lazım" by the author/singer Buray (2016). According to Kral Müzik (Haftanın En Çok Dinlenen Şarkıları, 2016) the song "Aşk mı Lazım" was listed as one of the most listened songs in Turkey in 2016. The chosen song has a vocal and an instrumental version, which were used in the music with vocals and music without vocals conditions respectively. Both versions the song duration is 3 minutes and 30 seconds.

2.3.4 Music Assessment Questions

A number of questions were used to collect information about the participant's general music preference, exercise habits, mean years of keyboard usage and concurrent activities in daily lives. Exercise, years of keyboard usage and dual tasking in particular have been shown to be important factors for executive functioning (Angevaren et al., 2008; Salthouse, 1984; Fraser et al., 2016), thus it was important to ensure that the participants were matched in terms of these variables. Further, questions related to the song used in the experiment were asked to the participants before and after data collection. These were prepared by researcher (see Appendix B). These questions included items such as “Did you like the vocal music you listened to while typing?”, “Have you heard of this song before?” or “How many hours do you exercise in a week?”.

2.4 Procedure

Firstly, following ethical approval from Eastern Mediterranean University, Department of Psychology, Research and Ethics Committee (see Appendix D), prospective participants were approached from the general community in Northern Cyprus and were provided with verbal and written information about the study aims. They were invited to participate in the study and those willing to partake were required to indicate their voluntary participation by signing the informed consent form. Participants were tested individually in a silent room at either the participants or researcher’s home or office. Participants initially performed the COWAT and prior to the experimental data collection session were allowed time to adjust their seating and become comfortable with the monitor and keyboard. Then, a practice typing test wherein participants typed a total of 10 words was administered to familiarize participants to the typing task, the keyboard, and stimulus presentation. This practice session was also run using custom algorithm written in MATLAB.

Then, the experimental session began in which participants’ typing speed and accuracy was measured under three experimental conditions (i.e., no music, music with vocals, and music with vocals). In each trial, words were presented on a computer screen and the participant was asked to type the presented word as fast and accurately as possible. Before each music condition (music with and without vocals) started participants were instructed to pay attention to the music to be able to answer questions related to the music after the experiment. By this way, participants were prevented from completely ignoring the music thus dual task conditions were created. Participants were instructed to start the each experimental condition by pressing the enter button when they were ready and to start the next trial by pressing the plus symbol (+) button on the number pad. In each trial, participants paused for 1.5 seconds after completing the typing task to have additional time to move fingers from plus symbol (+) to keys. For the no music condition, participants typed 50 words without listening to music, which constituted the baseline condition. For the music with vocals condition, participants typed a different set of 50 words while they concurrently listened to music with vocals, and for the music without vocals condition, participants typed another set of 50 words while they concurrently listened to music without vocals. Once participants completed the typing task under the three conditions, they were required to complete the music assessment questionnaire.

Participants' typing performance was measured under the three conditions (the same participants participated in all three conditions) on the same day and although short breaks was offered to participants between the conditions to avoid fatigue effects, only one participant rested between the conditions. Each condition approximately took five minutes to complete, however, the duration to complete the typing task was partly dependent on the typing speed of the participant. For the conditions with music, if the participant did not finish typing all the words once the music finished the song repeated to play. The total time required to complete the study was approximately 20-30 minutes. Upon completion of the experimental testing, participants were thanked for their participation and debriefed using the debrief form which further explained the aim of the current study.

2.5 Analysis

For each participant, the accuracy score in each condition was calculated by dividing the number of correctly typed words with the number of all words typed. Then the accuracy score was reported as a percent (%). For calculating the IKI, key-presses from only correctly typed words were included. IKI in incorrectly typed words were excluded in order to minimize the effect of error and post-error slowing (a confounding source of slowing, Rabbitt, 1978; Kalfaoglu & Stafford 2014). This was desirable because it was wanted as much of the change in IKI to be caused by the experimental conditions as possible.

In line with the study of Kalfaoglu and Stafford (2014), for each participant IKIs slower than the 99th percentile and faster than the 1st percentile were excluded to protect against the effects of outliers. IKI scores higher than 1000ms were further deemed as outliers and excluded from the analysis.

To represent the typing performance of the participants, typing speed (IKI) and accuracy was combined, following the method proposed by Thorne (2006) and Woltz and Was (2006). Accuracy of each participant was divided by their average IKI that gives a corrected accuracy score. This calculation corrects for any speed accuracy trade off the participants might have used to keep their speed or accuracy high. Such composite scores are shown to be more sensitive to experimental manipulations than performance speed or accuracy alone especially under circumstances where speed and accuracy is correlated as it is in typing (the faster the people type, the more likely are to make mistakes, Thorne, 2006; Vandierendonck, 2017; Woltz & Was, 2006; Yamaguchi, Crump & Logan, 2013). For example, two typist with an accuracy of 85% might be very different in their typing speed. The one with a faster typing speed (measured as IKI) will have a smaller IKI, so his/her accuracy will be divided by a smaller number, leading to a higher corrected accuracy. The name of this corrected accuracy score is simply "typing performance score" (TPS).

Chapter 3

RESULTS

For the purposes of this study, all data were collected by MATLAB © 2009 Psychtoolbox software and analyzed by Statistical Package for Social Sciences (SPSS version 20). To test each of the hypotheses, a mixed 2 (younger adults vs. older adults) x 3 (no music condition vs. music with vocals condition vs. music without vocals condition) two-way analysis of variance (ANOVA) was conducted. Furthermore, one participant who was in the younger group was excluded from further analysis because his/her baseline condition score (Accuracy = 92 %, IKI = 117.51 ms, TPS = 782.91) was identified as an outlier using visual inspection of the box-plots figures (his score was more than 1.5 inter-quartile range larger than the 3rd quartile) and because he had a TPS Z score of 2.74, which was larger than the cut-off used for identifying outliers (2.5). Therefore, further statistical analysis was carried out with a total of 59 participants. The mean and standard deviations of accuracy, IKI, TPS and COWAT scores are presented in Table 1.

Table 1: Mean TPS and COWAT of Younger and Older Adults (with standard deviations) under Music Conditions

Variables	Younger Adults	Older Adults
	M (SD)	*M (SD)*
No Music		
TPS	436.89 (121.21)	214.63 (93.06)
Music without Vocals		
TPS	414.68 (102.93)	212.38 (91.54)
Music with Vocals		
TPS	393.14 (91.75)	206.53 (84.63)
Total of COWAT Score	41.55 (11.05)	34.40 (8.66)

Note: When calculating TPS, Accuracy was divided by IKI as measured in seconds instead of millisecond.

3.1 Data Preparation

Prior to the analyses of each hypothesis, to test whether age groups (younger versus older adults) were matched on gender, handedness, employment status and language, chi-square tests were carried out, and results are presented in Table 2. A chi-square test was further carried out to determine whether age groups were equal in terms of practice in both listening to music and dividing their attention among concurrent tasks, which showed that the number of participants that frequently listen to music ($X^2(2, N = 59) = 5.191$, $p = .075$) and divide their attention between two tasks ($X^2(1, N = 59) = .126$, $p = .723$) in their daily life did not differ by age group. Furthermore, to ensure that age groups did not differ with regard to whether they knew the song played in the current study, to determine that participants in both groups equally attended to the song while concurrently typing, further chi-square results were carried out and are presented in Table 3. On the other hand, to determine whether age groups were matched on the total score of controlled oral word association test, an independent sample t-test was carried out, revealing of significant group differences *t* (57) = 2.77, p = 0.008. Younger adults (M = 41.55, SD = 11.05) were found to have a higher COWAT score than older adults (M = 34.40, SD = 8.65). No significant correlation was however found between younger adult's COWAT and TPS in the baseline condition (r = .334, p = .07), music without vocals condition (r = .318, p = .09) or music with vocals condition (r = .075, p = .70).

Table 2: Demographic Characteristics of Younger and Older Adults

	Younger Adults *(N=29)*		Older Adults *(N=30)*	
Characteristics	*N*	*%*	*N*	*%*
Gender				
Male	13	44.8	11	36.7
Female	16	55.2	19	63.3
Chi-square	.407			
Handedness				
Left	3	10.3	2	6.7
Right	26	89.7	28	93.4
Chi-square	.257			
Employment Status				
Not employed	13	44.8	4	13.3
Employed	16	55.2	26	86.7
Chi-square	7.131*			
Language				
Monolingual	12	41.4	16	53.3
Bilingual	17	58.6	14	46.7
Chi-square	.845			
Mean Years of Keyboard Usage	29	11.31	30	15.40
Chi-square	21.942			
Mean Hours of Exercise	29	3.48	30	2.10
Chi-square	12.730			

Note: **p<.05*

Table 3: Acquaintance and Enjoyment of Song "Aşk mı Lazım"

Questions	Answers	Younger Adult		Older Adult	
		N	%	N	%
Acquaintance of vocal song	Yes, lyrics are know by heart	20	69.0	4	13.3
	Yes, has listened to song several times	8	27.6	23	76.7
	No, has never heard of song before	1	3.4	3	10.0
	Chi Square	18.913**			
Enjoyment of vocal song	Yes	28	96.6	28	93.3
	No	1	3.4	2	6.7
	Chi Square	.316			
Sing along to vocal song while typing	Yes, whole of the lyrics	7	24.1	4	13.3
	Yes, some part of the lyrics	14	48.3	16	53.3
	No	8	27.6	10	33.3
	Chi Square	1.157			
Acquaintance of instrumental song	Yes, listened to song many times	1	3.4	1	3.3
	Yes, listened to song several times	2	6.9	8	26.7
	No, has never heard of song before	26	89.7	21	70.0
	Chi Square	4.116			
Enjoyment of instrumental song	Yes	21	74.4	25	83.3
	No	8	27.6	5	16.7
	Chi Square	1.023			
Sing along to instrumental song while typing	Yes, whole of the lyrics	2	6.9	1	3.3
	Yes, some part of the lyrics	15	51.7	7	23.3
	No	12	41.4	22	73.3
	Chi Square	6.168*			

Note: $^{*}p<.05$; $^{**}p<.01$

3.2 Impact of Listening to Music and Age on Typing Performance

To test the impact of listening to music, the mean TPS were compared across the no music, music with vocals, and music without vocals conditions for all participants. It was found that there was a significant main effect of listening to music on typing performance, $F(2, 114) = 5.82$, $p = .004$, $\eta p^2 = .093$. Participants' TPS was higher in no music condition ($M = 325.75$, $SD = 14.03$) compared to music with vocals ($M = 299.83$, $SD = 11.48$) and without vocals ($M = 313.53$, $SD = 12.66$) conditions. However, there was no significant difference between the TPS during music with and without vocals conditions on typing performance. To test the impact of age, the mean TPS of younger and older adults were compared in all three conditions. It was found that there was a significant main effect of age on typing performance, $F(1, 57) = 72.09$, $p < .001$, $\eta p^2 = .558$, in which older participants ($M = 211.18$, $SD = 16.82$) had poorer typing performance score compared to younger participants ($M = 414.90$, $SD = 17.11$). However, there was no interaction between the music conditions (no music, music with vocals, and music without vocals) and age $F(1, 57) = 2.31$, $p = .13$, $\eta p^2 = .039$.

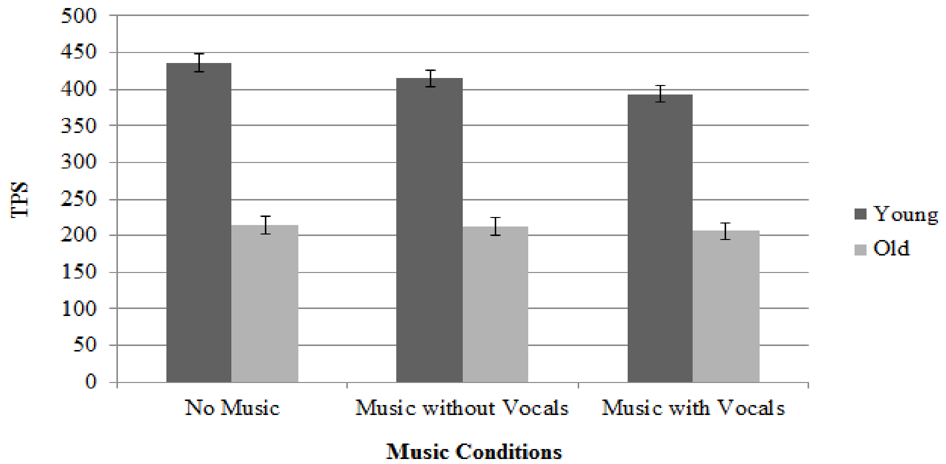

Figure 1: Mean TPS of younger and older groups in all conditions. Error bars represent standard error of each mean.

Chapter 4

DISCUSSION

The present study aimed to explore the effects of listening to music (with and without vocals) on typing performance of younger and older adults. Considering that performing dual tasks requires more cognitive capacity than single tasks (Craik & Byrd, 1982), a reduction in typing performance was expected when participants were required to type words and concurrently listen to music (with and without vocals) compared to when they were required to type words in the absence of music. This expectation was supported. Participants' overall typing performance score decreased during the music (in both with and without vocals) conditions compared to the no music condition.

Furthermore, since task performance is more likely to decrease when dual tasks demand the same (compared to different) resources (e.g., linguistics, Wickens, 2002), it was expected that participants' typing performance score would be worse under the music with vocals condition compared to the music without vocals condition. However, this expectation was not supported. The effect of listening to vocal vs. instrumental music on participants' typing performance score was not significantly different.

As with regard to aging, older age has been previously shown to negatively affect frontal lobe functioning and skills of executive functions (Haug & Eggers, 1991;

West, 1996). These are important functions for typing process. The current study therefore expected that older adults would have a lower typing performance score compared to younger adults. Results supported this expectation. It was found that older adults in all conditions (i.e., no music, music with and without vocals) were worse in their typing than the younger adults.

Moreover, since the frontal lobes coordinate the performance of dual tasks, which is affected by normal aging (Craik & Byrd, 1982), the current study expected that older adults' typing performance would be affected more from the music conditions (music with and without vocals) than younger adults. However, this expectation was not supported. The drop in TPS of older participants during music conditions compared to no music condition was not significantly larger than that of younger participants. Overall, these results indicate that hypotheses 1 and 3 were supported, however hypothesis 2 and 4 were not supported.

In the current study, younger and older participants were found to type worse (as reflected in their typing performance score) when they were required to type and concurrently listen to the vocal and instrumental music compared to when they typed without music. These findings indicate that people experience a decrease in their typing performance when they are required to undertake a second concurrent activity such as listening to music. One reason for this might be because of the limited amount of attentional resources that can be allocated to performance of tasks (Kahneman, 1973). When multiple tasks are required to be performed, this limited capacity is allocated to all tasks and as a result each task receives less resource to be effectively executed. If one task does not receive the amount of resources it needs to be effectively executed, performance on that task decreases (Kahneman, 1973). In the current study, less attentional resources were allocated to the typing process leading to a reduction in typing performance, as a result of having to listen to music.

Despite some methodological differences (e.g., type of music, assessment of typing performance), the current findings are similar to those of past studies (i.e., Jensen, 1931; Jiang & Sengupta, 2011; Ransdell & Gilroy, 2001) that find a detrimental impact of listening to music on typing. For instance, although in Jensen's (1931) study dirge and jazz music was employed, in the Ransdell and Gilroy's (2001) study slow paced music was employed, and in the Jiang and Sengupta's (2011) study and current study fast paced music was employed, all studies reveal a decrease in typing performance measured either as the number of words generated (Ransdell & Gilroy, 2001), words typed per minute (Jiang & Sengupta, 2011), or a combination of speed and accuracy (i.e., findings of the current study).

At a first glance, current findings seem to differ from those of Cho (2015), which reveal a beneficial effect of fast paced music on typing performance. However, it is important to note that Cho only found a positive effect of music on the *number of pauses* made between generating words (i.e., fewer pauses) and not with regard to the quality or fluency of the writing. Since the dependent variables used by Cho (2015) are qualitatively different than those used in the current study, it is difficult to directly compare the findings from these two studies. It is particularly difficult to suggest that the finding of decreased performance in terms of speed and accuracy contradicts the finding of Cho (2015) of less pauses in essay writing due to presence of a concurrent task. Neither the number nor the duration of pauses are measured by the current study. Overall, findings of the current study coupled with those past studies (Jensen, 1931; Jiang & Sengupta, 2011; Ransdell & Gilroy, 2001) reveal of a disruptive effect of music on one's ability to effectively type words and sentences.

In addition to examining the overall effect of listening to music on typing performance, the current study further examined the impact of vocal versus instrumental music (Hypothesis 2). According to the multiple resource theory (Wickens, 1984), when participants require the same type of resources (i.e., linguistic) to perform concurrent tasks their performance decreases more compared to when they require resources from a different pool. A greater decrease in typing for the vocal compared to the instrumental music condition was thus expected because typing requires linguistic resources to process and type words (Wickens, 2002). The vocal condition also demands linguistic resources to process the song lyrics while the instrumental music condition does not. Findings however revealed that typing performance of both younger and older adults did not differ between vocal and instrumental music condition.

Although the current findings do not support the second hypothesis, it is similar to that of Ransdell and Gilroy (2001) which also found no significant difference in typing self-generated words between the vocal and instrumental conditions. However, past studies (e.g., Salame & Baddeley, 1989) do find that performance on a memory task (i.e., recall of nine visually presented sequences of digits in correct order) decreases more when individuals concurrently listen to vocal music compared to instrumental music. This suggests that task performance differences between vocal and instrumental conditions may become apparent when the task requires a significantly higher demand on phonological and language related mental resources as was the case in Salame and Baddeley (1989). In Salame and Baddeley's (1989) study, participants had to keep in mind the sequences of nine visually presented digits to recall and write them with a correct order as presented. It is argued that this task demands a greater amount of phonological and language related resources compared to the task in the current study. In the current study, participants had to hold in mind and type only one five letter word that was presented on the computer screen until the participant completed typing it in each trial. It is plausible that typing words presented on the screen while listening to music with vocals may not be significantly more taxing on the linguistic resources compared to keeping in mind and trying to recall the presented sequences of digits while listening to music with vocals. For example, anecdotal evidence suggests skilled typists can even hold conversations while copy-typing (Rabbitt, 1978). Whether vocal music is disruptive to task performance compared to instrumental music might be thus related to differences in task demands. The tasks that demand more phonological resources are likely to be more susceptible to decrements in performance than those that do not when the concurrent task also requires phonological processing (Baddeley, 2004; Kahneman, 1973). In light of this view, lack of difference between TPS during vocal vs. instrumental music conditions might be due to the minimal amount of demand on typing task on language related and phonological processing resources (e.g. the phonological loop, Baddeley, 2004).

Alternatively, it is also possible that the participants in the current study did not focus on the lyrics and meanings of the song. Hence, similar to the instrumental condition the vocal condition may not have demanded linguistic resources, thereby accounting for the non-significant differences in the typing task performance. Although, findings of the current study showed that the vocal music was liked more (94.9 %) than the instrumental version of the pop song (78.00 %), the current study was limited in confirming whether participants did or did not focus on the lyrics of the song. Hence, future studies are needed to clarify this notion and determine whether differences between music conditions (i.e., vocal & instrumental) exist when performing a typing task.

To determine whether aging affects cognitive processing, age-related differences on typing performance were further investigated by the current study. As expected, older adults were found to type worse (as reflected in their typing performance) compared to younger adults across all conditions (i.e. no music, music with and without vocals). Such findings indicate that the ability to type words, which includes both cognitive and motor processes and require executive functions, is affected negatively by aging. The frontal hypothesis of aging proposes that prefrontal cortex functions (i.e., executive control, working memory, and attention) start to decline and this becomes observable in the 4th decade of life (Haug & Eggers, 1991). Thus, as age increases, individuals generally have difficulty in performing cognitive tasks which rely on the prefrontal cortex of the brain, such as memory and executive control (West, 1996).

Although the above explanation for the age-related reduction in typing performance suggests the functional deterioration of prefrontal cortex might be causing the observed decrease in typing performance, the findings of the current study surprisingly found that the effect not be related to an important prefrontal function (executive processes): The effect of music on older adults' ability to type was no different than that on younger adults ability to type. In other words, the effect of music on typing performance was not affected by age. This suggests the drop in TPS may not be due to the reduction in executive functioning in older age. A more likely explanation for the age related effects in the current study is a reduction in processing speed in older age (Salthouse, 1996). This point will be explored in more detail in the discussion of the results related to the 4th hypothesis.

Findings of the current study show that the accuracy score was similar in all conditions (i.e., baseline, vocal, and instrumental music) for both younger and older adults[1]. However, there were significant age related differences in IKI scores which represent typing speed[2]. Such findings indicate that the decline in the TPS of older adults was not due to the decline in typing accuracy but due to a slowing in typing speed. This is in line with the processing-speed hypothesis, which suggests that age-related cognitive decline in performance is due to a reduction in the speed of sensory or motor processes (i.e., finger movements, Salthouse, 1996). Overall, older adults typed as accurately as younger adults, however older adults were able to attain such levels of accuracy by typing substantially slower than younger adults in all conditions (i.e., baseline, vocal and instrumental music).

There may be other possible reasons for the finding that the effect of music on older adults and younger adults was not different in the present study, which are related with factors that might improve executive functions. For example, self-reported demographic information gathered from the participants showed that older adults' keyboard usage years and hours of exercise per week was as high as that of younger

[1] There was no statistically significant difference between younger and older adults' accuracy scores under no music condition (U = 398, z = -.564, p = .573), music without vocal condition (U = 384.50, z = -.769, p = .442), music with vocal condition (U = 363.50, z = -1.091, p = .275).

[2] There was a statistically significant difference between younger and older adults' IKI scores under no music condition (U =25, z = -6.216, p < .001), music without vocal condition (U = 45, z = -5.913, p < .001), music with vocal condition (U = 43, z = -5.943, p < .001)

adults. Moreover, most of the older adults reported that in their daily lives they usually engage in performing another concurrent activity (e.g., driving, typing) while listening to music. Evidence shows that doing exercise and having practice on single and dual task increases executive functioning (Angevaren et al., 2008; Salthouse, 1984; Fraser et al., 2016), thus information collected from older participants suggest that their expertise in typing and executive functioning may have been similar to that of younger adults. Although the current results may be accounted for by improved executive functioning in older adults, other factors such as playing video games and trying to learn new things may contribute to the non-significant findings in typing performance between younger and older adults in the music condition, which needs to be examined further.

There were several limitations in this study. First of all, although demographic informations such as gender, handedness, and language were similar between the age groups, employment status was not. Namely, in the current study, 87 % of older adults were employed whereas, 55 % of younger adults were employed. This is important because being in employment positively affects executive functioning (Kalechstein, Newton & Van Gorp, 2003). It is possible that the high number of employment in the older group prevented the occurrence of age related decline in executive functioning, thus no differences in typing performance in the music conditions were found between the age groups.

Additionally, literature suggests that having a high level of education positively affects executive functioning (Bosma, Van Boxtel, Ponds, Houx & Jolles, 2003). It was however not measured in the current study and thus it could not be tested whether education level was balanced between age groups or not. It might be possible to indicate that if older adults' education level was higher than that of younger adults, the age-related decline in executive functioning could not be observed. It would thus be important for future studies to balance age groups on education level.

A number of factors such as amount of practice in typing can have an effect on typing performance (Salthouse, 1984). Although participants' keyboard usage years, a determinant of practice, was matched between age groups, their frequency of daily usage of the keyboard (i.e., the amount of time they spend typing per day) also a determinant of practice, was not obtained from participants. Groups were therefore not matched on this factor. This limited the interpretation of the current results. This is because if younger adults' daily usage of the keyboard was higher than older adults, it might be possible that younger adults' higher TPS was a reflection of their greater practice in typing than a cognitive decline due to age. It is therefore important that future studies match age groups on a wider range of variables including frequency of keyboard usage when assessing for typing ability.

On the other hand, there were some considerable differences between younger and older groups on the answers of post-experiment questions related with the chosen pop song which were listened during the music conditions. That means, the lyrics of the song were known by heart by 69 % of younger adults vs. only 13% of the older adults. Besides that, 73 % of the older adults reported not singing along to instrumental version of the song, however, 41 % of the younger adults did not sing along to instrumental version of the song. Since the older adults did not know the vocals of the song, their TPS might not be affected more by the vocal music than instrumental music. This might have prevented finding possible differences between vocal and instrumental music on TPS. Therefore, the song which will be chosen in the future study should emphasize that notion.

Furthermore, in the current study, younger and older adults' typing performance under three music conditions was compared at a single point in time. This prevents dissociating the effects of age from cohort effects (i.e. inter-generational differences, Schaie, 2005). Past studies (Schaie, 2005; Schaie, Willis & Pennak, 2005) suggest that when examined at the same age range, people who are born in more recent years have better performance on cognitive and physical tasks compared to those born in earlier years. Therefore the reason why older adults had less TPS than younger adults in the current study might be at least partially cohort differences rather than age related decline itself. To prevent the cohort differences when assessing age related decline in typing performance, longitudinal analysis (i.e., same individual assesses over a period of years) can be used in the future studies.

The current study has a number of implications for retaining the ability to type fast and accurately an important requirement in today's society. For instance, the necessity for students to complete assignments through typing is increasing based on the commonly usage of computers in educational setting. Also, typing is a skill needed in almost all employment settings which can increase work efficiency. Consequently, students and employers need to type as fast and accurately as possible in order to timely accomplish their tasks. To do so, they would need to avoid factors such as listening to music that can disrupt their task performance according to the results of the present study. The current findings along with those of other studies (Jensen, 1931; Jiang & Sengupta, 2011; Ransdell & Gilroy, 2001) show the disruptive effects of listening to both vocal and instrumental music on typing performance. Hence, the advice from this study is clear; if the goal of typing is to produce the maximum number of correctly spelled words per given time, while listening to music, even if it is instrumental, is likely to have a negative effect.

Another important implication is related to the effects of aging. As discussed above, the findings of the current study suggests that older adults' performance on dual-tasking was not worse than younger adults. This might be because older adults' executive functioning may have increased through some factors such as doing exercise and frequent engagement (i.e., practice) in dual-tasking. That suggestion is in line with the *use it or lose it* principle (Mahncke et al., 2006), which indicates that it is possible to improve cognitive ability throughout life in response to the mental activity one is engaged in (i.e., practice, exercise, puzzle). Importantly, this suggests that cognitive decline is not unavoidable in older adults. So, the current study suggests that older adults can improve their own executive functioning and recommend that educational programs be established to inform older adults on ways (e.g., exercise training) to improve their own executive functioning (Angevaren et al., 2008).

Overall, findings of the current study show that younger and older participants performed better on a typing task under a no music condition compared to a music with and without vocals condition. These findings suggest that concurrently listening to both vocal and instrumental music disrupts typing performance of individuals. Furthermore, although typing performance was higher for younger adults than older adults under all music conditions, older adults were not affected more by concurrently listening to music than younger adults. These finding indicate that performance in dual tasking (i.e., listening to music and typing) which requires executive functioning was not affected by age-related decline. Future studies are needed to improve the understanding of the factors that affect the performance of typing, a necessity for everyday life.

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APPENDICES

Appendix A: Controlled Oral Word Association Test (COWAT)

Kontrollü Kelime Çağrışım Testi

Aşağıdaki kutucuğa ‘K’ harfi ile başlayan kelimeler yazınız. Lütfen yazacağınız kelimelerin özel isim (Kübra, Kayahan vb.) ve yer ismi (Kıbrıs, Konya vb.) olmamasına dikkat ediniz.

Aşağıdaki kutucuğa ‘A’ harfi ile başlayan kelimeler yazınız. Lütfen yazacağınız kelimelerin özel isim (Ali, Ayşe vb.) ve yer ismi (Ankara, Adana vb.) olmamasına dikkat ediniz.

Aşağıdaki kutucuğa 'S' harfi ile başlayan kelimeler yazınız. Lütfen yazacağınız kelimelerin özel isim (Selin, Sedat vb.) ve yer ismi (Samsun, Sivas vb.) olmamasına dikkat ediniz.

Appendix B: Music Assessment Questions

Çalışma Öncesi Genel Bilgi Formu

Aşağıdaki soruları lütfen cevaplayınız ve size en yakın gelen seçeneğin yer aldığı kutucuğu işaretleyiniz. Lütfen boş bırakmayınız.

1- Günlük hayatınızda ne sıklıkla müzik dinlersiniz?

- ○ Her gün (1)
- ○ Sıklıkla (2)
- ○ Nadiren (3)
- ○ Hiçbir zaman (4)

2- Hangi tür müziklerden hoşlanırsınız?

- ☐ Pop (1)
- ☐ Klasik (2)
- ☐ Caz (3)
- ☐ Arabesk (4)
- ☐ Rock (5)
- ☐ Enstrümental (Sözsüz Müzik) (6)
- ☐ Slov (7)
- ☐ Rap (8)
- ☐ Diğer: ________

3- Müzik dinlerken başka aktivitelerde (spor yapmak, ders çalışmak, bilgisayarda yazı yazmak vb.) bulunuyor musunuz? Cevabınız "Evet" ise bu aktiviteleri aşağıdaki boşluğa yazınız.

____

4- Günlük hayatınızda haftada kaç saat egzersiz yapıyorsunuz?

____

5- Kaç yıldır klavye veya daktilo kullanıyorsunuz?

____

Çalışma Sonrası Genel Bilgi Formu

Aşağıdaki soruları lütfen cevaplayınız ve size en yakın gelen şıkkın yer aldığı kutucuğu işaretleyiniz. Lütfen boş bırakmayınız.

1- Katıldığınız çalışmada dinlediğiniz sözlü müziği (Aşk mı Lazım) daha önce dinlemiş miydiniz?

- ○ Evet, ezbere biliyorum. (1)
- ○ Evet, daha önce bir kaç kez dinledim. (2)
- ○ Hayır, daha önce hiç dinlemedim. (3)

2- Katıldığınız çalışmada dinlediğiniz sözlü müziği (Aşk mı Lazım) beğendiniz mi?

- ○ Evet. (1)
- ○ Hayır. (2)

3- Katıldığınız çalışmada dinlediğiniz sözlü müziği (Aşk mı Lazım) klavyede yazı yazarken içinizden söylediniz mi? Cevabınız "Evet" ise şarkının tüm kısmına mı yoksa belirli bir kısmına mı eşlik ettiniz?

[ ]

4- Katıldığınız çalışmada dinlediğiniz enstrümental (sözsüz) müziği daha önce dinlemiş miydiniz?

- ○ Evet, daha önce sıklıkla dinledim. (1)
- ○ Evet, daha önce bir kaç kez dinledim. (2)
- ○ Hayır, daha önce hiç dinlemedim. (3)

5- Katıldığınız çalışmada dinlediğiniz sözsüz müziği beğendiniz mi?

- ○ Evet. (1)
- ○ Hayır. (2)

6- (Lütfen bu soruyu çalışmada dinlediğiniz (Aşk mı Lazım) şarkının sözlerini biliyorsanız cevaplayınız, bilmiyorsanız boş bırakınız). Katıldığınız çalışmada dinlediğiniz enstrümantal müziğin sözlerini içinizden söylediniz mi? Cevabınız "Evet" ise şarkının tüm kısmına mı yoksa belirli bir kısmına mı eşlik ettiniz?

[ ]

Appendix C: List of Words

balta	korku	delil	mutlu	sinek	duygu
orman	bitki	kumru	devam	yarar	kabuk
kitap	onlar	hayal	kimse	hesap	belli
resim	garip	rakam	gelin	kilit	lamba
kalem	esrar	sayfa	oynak	sokak	sonra
tarih	kesin	neden	temiz	fener	seyir
bilgi	merak	detay	fanus	opera	nefes
ciddi	Fazla	kavram	yalan	sahne	ileri
kolay	bilgi	toprak	sevgi	aylak	duvar
insan	minik	derin	kulak	sivri	zehir
vakit	gurur	narin	sinir	tuzlu	acele
fikir	biraz	filiz	durum	keder	engel
sahip	yaban	sabah	beyaz	tilki	buruk
deney	model	kolay	karar	evcil	nokta
cevap	sefer	zarar	herkes	tavuk	bilim
anlam	zaman	ihmal	evren	tarla	hafif
motor	pembe	ahlak	deniz	tatil	keyif
yolcu	hayat	kural	sakin	makas	bilek
tamir	masal	basit	talep	burun	devir
sebep	saman	sonra	bakan	bebek	beden
koyun	boyun	sorun	araba	uzman	lider
ifade	giysi	diken	uygun	damla	alaka
tutku	kapak	sanki	tuhaf	dudak	ekmek
hayal	fidan	meyve	kenar	derin	kadar
susuz	tohum	masum	huzur	soluk	helal

Appendix D: Department's Ethics and Research Committee Approval Letter

Doğu Akdeniz Üniversitesi
"Uluslararası Kariyer İçin"
Eastern Mediterranean University
"For Your International Career"
P.K.: 99628 Gazimağusa, KUZEY KIBRIS / Famagusta, North Cyprus, via Mersin-10 TURKEY
Tel: (+90) 392 630 1995
Faks/Fax: (+90) 392 630 2919
bayek@emu.edu.tr

Etik Kurulu / *Ethics Committee*

Sayı: ETK00-2017-0023

19.01.2017

Sayın Nilay Usta
Psikoloji Bölümü
Yüksek Lisans Öğrencisi

Doğu Akdeniz Üniversitesi Bilimsel Araştırma ve Yayın Etiği Kurulu'nun ***16.01.2017*** tarih ve ***2017/38-25*** sayılı kararı doğrultusunda ***The Effects of Listening to Music with Lyrics on Younger Adults Typing Performance*** adlı tez çalışmanızı, Yrd. Doç. Dr. Çığır Kalfaoğlu ve Yrd. Doç. Dr. İlmiye Seçer'in danışmanlığında araştırmanız Bilimsel ve Araştırma Etiği açısından uygun bulunmuştur.

Bilginize rica ederim.

Doç. Dr. Şükrü Tüzmen
Etik Kurulu Başkanı

ŞT/sky.

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