

Articulation and Speech Rates in Speaking and Reading of Youngest-Old and Middle-Old Adults

Genç Yaşlılık ve Orta Yaşlılık Dönemindeki Bireylerin Konuşmada ve Okumada Artikülasyon ve Konuşma Hızlarının İncelenmesi

İlayda GÜNDÜZ^a, Mehmet Emrah CANGİ^b

^aÜsküdar University Institute Health Sciences, Department of Language and Speech Therapy, İstanbul, Türkiye

^bUniversity of Health Sciences Hamidiye Faculty of Health Sciences, Department of Language and Speech Therapy, İstanbul, Türkiye

The first author's (İG) MSc dissertation was supervised by the second author (MEC) and provides the basis for this study. Teze ait bilgilerin (başlık, yazar, yıl, üniversite) cümleye eklenmesi gerekir.

ABSTRACT Objective: Speech and articulation rates are components of prosody and provide information about certain functions and developmental processes. This study primarily aimed to obtain normative preliminary data on the speech and articulation rates of youngest-old and middle-old adults in speaking and reading, and to compare the data in terms of demographics. The secondary aim of this study was to present the correlations between the cognitive performances of the participants. **Material and Methods:** A total of 50 youngest- and middle-old participants (65-74 and 75-84 years old) whose native language was Turkish were included. A sample of spontaneous speech and reading was analyzed with Praat Acoustic Analysis Program software. Cognitive screening of the participants was performed via the Standardized Mini-Mental State Examination (SMMSE). **Results:** The speech rate of the participants in speaking was 256 syllables per minute (SPM), the articulation rate in speaking was 359.5 SPM, the speech rate in reading was 235.5 SPM, and the articulation rate in reading was 310.5 SPM. There was no statistically significant correlation between SMMSE scores and speech and articulation rates in speaking and reading. When the normative data were compared in terms of gender, the male participants' speech and articulation rates in speaking and reading were found to be higher than those of females. **Conclusion:** In this study, the speech and articulation rates of the participants were found to be lower in speaking and reading compared to previous studies with younger age groups.

Keywords: Speech rate; articulation rate; reading rate; youngest-old; middle-old

ÖZET Amaç: Prozodinin bileşenleri olarak kabul edilen konuşma ve artikülasyon hızı, bazı işlevler ve gelişimsel süreçler hakkında bilgi sağlamaktadır. Çalışmanın temel amacı, genç yaşlılık ve orta yaşlılık dönemindeki bireylerin konuşma ve artikülasyon hızlarına ilişkin normatif ön veriler elde etmek ve bu verileri demografik faktörlere göre karşılaştırmaktır. Çalışmanın ikincil amacı, katılımcıların bilişsel performansları ile konuşma ve artikülasyon hızları arasındaki ilişkinin belirlenmesidir. **Gereç ve Yöntemler:** Ana dili Türkçe olan genç-yaşlılık (65-74 yaş) ve orta yaşlılık (75-84 yaş) dönemindeki toplam 50 katılımcı çalışmaya dâhil edilmiştir. Spontane konuşma ve okuma örnekleri Praat Akustik Analiz Programı yazılımı kullanılarak analiz edilmiştir. Katılımcıların bilişsel taraması Standardize Mini-Mental Test (SMMT) ile gerçekleştirilmiştir. **Bulgular:** Katılımcıların konuşmada konuşma hızı 256 hece/dk (H/D), konuşmada artikülasyon hızı 359,5 H/D, okumada konuşma hızı 235,5 H/D ve okumada artikülasyon hızı 310,5 H/D olarak bulunmuştur. Bununla birlikte, SMMT skorları ile konuşma ve okumada konuşma ve artikülasyon hızları arasında istatistiksel olarak anlamlı bir ilişki bulunmamıştır. Normatif veriler cinsiyet bağlamında karşılaştırıldığında, erkek katılımcıların konuşma ve okumada konuşma ve artikülasyon hızlarının, kadınlara göre daha yüksek olduğu bulunmuştur. **Sonuç:** Bu çalışmada, katılımcıların konuşma ve okumada konuşma ve artikülasyon hızlarının daha genç yaş gruplarıyla yapılan önceki çalışmalara göre daha düşük olduğu bulunmuştur.

Anahtar Kelimeler: Konuşma hızı; artikülasyon hızı; okuma hızı; genç yaşlılık; orta yaşlılık

Correspondence: Mehmet Emrah CANGİ

University of Health Sciences Hamidiye Faculty of Health Sciences, Department of Language and Speech Therapy, İstanbul, Türkiye

E-mail: emrahcangi@gmail.com



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Speech rate, which is accepted as a component of prosody, is closely related to many functions and developmental processes.¹ Speech rate and articulation rate refer to the numbers of syllables per minute (S/M) or words per minute.² While pauses longer than 2 sec are removed when calculating speech rate, those longer than 250 ms are removed when calculating articulation rate.^{1,3} These two closely related variables are two different phenomena representing different dynamics. For example, speech rate is more integrative.⁴ Adding pause patterns in speech reveals several details about the person. Speech rate can reflect a variety of factors, including individual, demographic, cultural, linguistic, developmental, psychological, and physiological characteristics.^{1,4,5} Articulation is a parameter that is primarily associated with motor performance and represents the speed of syllable production in speech, excluding personal nuances like hesitations, pauses, and emotional expressions.⁶

Speech rate and articulation rate are important variables for many disorders.⁷ For instance, in voice disorders, an increased speech rate can indicate a higher risk of functional voice disorders due to increased hyperfunctional voice use and glottal attacks.^{8,9} Moreover, assessing speech rate and articulation rate is crucial for evaluating conditions like neurodegenerative diseases, motor speech disorders, and fluency disorders.¹⁰ The rate of speaking, particularly associated with development and age, can be influenced by various factors linked to the aging process, such as physiological changes, cognitive abilities, memory, social factors, and linguistic processing disparities.^{11,12} Several studies in the literature have revealed that speech rate and articulation rate decrease as individuals age.^{11,13-15}

Previous studies in the relevant literature have been carried out mostly in English and with children and young adults.^{1,16-21} Block and Killen (2014), found that Australian children and adults speak faster than previously reported, with children averaging 176 SPM in conversation and 159 in reading, while adults averaged 237 and 230 SPM, suggesting speech therapists may need to adjust their treatment goals regarding speech rate.¹⁶ Lee and Doherty, examined speaking and articulation rates in Irish English, finding that speakers of this dialect exhibit relatively

higher rates compared to other English dialects, with men generally speaking faster than women, particularly during reading.¹⁸ In Turkish, Cangi et al. examined speech rate and articulation rate in young adults. The authors concluded that, compared to other languages in the literature, the speech rate in Turkish is low while the articulation rate is high among young adults aged 19-24.²² İyigün et al. investigated the reading rates of individuals between the ages of 20-56 and those over the age of 56. They observed that individuals in the age group of 20-35 had a higher reading rate than those in the age group of 46-55.²³ Many studies have reported that gender significantly influences speech and articulation rates; men generally have higher rates than women.^{6,14,17,18} Similar findings have been observed in studies examining reading rates.^{6,18} However, some studies have investigated the gender variable and found no significant differences between men and women.^{3,16,22,23}

As in the rest of the world, the ratio of the population over the age of 65 is increasing in Türkiye, and it is expected to increase even more in the future.²⁴ Because there are both physiological and neurological differences between young adults and the elderly population, using research conducted on the young population as the sole reference in research and clinical practices regarding the elderly population may lead to misleading conclusions.¹² The main purpose of this study is to present preliminary normative findings about the articulation rate and speech rate values of the youngest-old (aged 65-74 years) and middle-old (75-84 years) native speakers of Turkish in speech and reading. Another goal of this study is to see if these rates and variables are influenced by demographic factors. Cognitive functions, particularly attention, memory, and executive functions, impact a significant influence on speech and language processes. Numerous studies have reported a significant correlation between speech rate and the frequency of pauses during speech with the severity of cognitive impairment.^{34,35} Nonetheless, the final objective is to investigate the relationship between cognitive functions and speech and articulation rates within the context of cognitively healthy aging individuals by examining the correlations between the results of Standardized Mini-Mental State Examination

(SMMSE), which were among the inclusion criteria, and the investigated speech and articulation rates.²⁵

MATERIAL AND METHODS

PARTICIPANTS

This study included a total of 50 individuals at the youngest-old (65-74) and middle-old (75-84) age groups, based on World Health Organization's definitions of aging categories.³⁶ The inclusion criteria specified participants as native Turkish speakers without language or speech disorders, neurological or psychiatric disorders, hearing impairments, or prior language and speech therapy. The exclusion criterion was a score below 24 on the SMMSE, a tool assessing memory, attention, language, orientation, motor function, and visual-spatial skills, used for mild dementia diagnosis.²⁵

While 34 of the participants were men, 16 were women. In the youngest-old age group, 29 out of 31 men and 8 out of 12 women were literate. In the middle-old age group, 2 out of 4 women and 2 out of 3 men were literate.

The study was carried out in accordance with the Declaration of Helsinki's guidelines and was approved by the of the Üsküdar University Non-Interventional Research Ethics Committee (date: May 31, 2021; no: 61351342/May 2021-80). All participants signed consent forms that included all pertinent information such as the purposes of the study and procedures.

DATA COLLECTION INSTRUMENTS

SMMSE

The SMMSE, which has been commonly used in the international literature to diagnose mild dementia, was tested for validity and reliability in Türkiye by Güngen et al. In this study, individuals who received scores of 24 or higher on the SMMSE were included.²⁵

Personal Information Form

This form, designed by researchers, contained questions about participants' daily lives, hobbies, living environment, occupations, retired occupations, books read, television and movie preferences, and regular

program choices to guide conversations with each participant on these topics.

ACOUSTIC VOICE ANALYSIS

Praat Acoustic Analysis Program (PRAAT)

PRAAT, developed by Paul Boersma and David Weenink at the University of Amsterdam in 1992, is a speech analysis software used to analyze, synthesize, and manipulate speech.²⁶ In this study, a 300-syllable section of spontaneous speech from a video was converted to audio using iMovie, then analyzed with PRAAT. Pauses longer than 2 seconds were excluded from speech and reading rate calculations, while pauses over 250 ms were excluded from articulation rate calculations.^{1,3} Speech rate and articulation rate were determined by calculating the number of syllables produced per minute.²

DATA COLLECTION

The data collection process was conducted in the speech and language disorders laboratory of the university where the research took place. First, the objective of the study was explained to the participants, their consent was obtained, and a short information form was filled out to collect their personal information. The SMMSE, which is used to exclude cognitive disorders, was administered to the participants.²⁷ Spontaneous speech and reading samples were individually collected by the first researcher through face-to-face sessions with each participant. In order to collect sufficient speech and reading samples, each recording session lasted a minimum of 10 minutes and was conducted in a controlled environment designed to make participants feel comfortable and secure, with minimal ambient noise interference. Spontaneous speech samples were collected by asking the participants the questions on the personal information form, Spontaneous speech samples were collected by asking the participants the questions on the personal information form, and reading speech samples were collected by having the participants read a part of a reading text named "Mavi Yolculuk" (Blue Cruise), which consisted of a total of 300 syllables, and is routinely used for data collection and clinical assessment purposes by speech and language therapists at the Speech and Language Therapy Research and Prac-

tice Center at Üsküdar University. Among the participants, reading samples were not obtained from the 9 individuals who were illiterate, and these participants were excluded from the statistical analyses of speech and articulation rate in reading (Table 1).

DATA ANALYSIS

The data was analyzed using IBM SPSS 26.0, employing descriptive statistics (mean, standard deviation, minimum, and maximum). Statistical tests like paired-sample t-test and Wilcoxon signed-rank test used to compare the speech and articulation rates of the participants, independent-sample t-test and Mann-Whitney U test were used to compare the data between the sexes, and Pearson's correlation analysis was used to calculate the correlations between the data and SMMSE scores. The analyses were carried out with a 95% confidence interval, and the level of statistical significance was accepted as $p < 0.05$.

RESULTS

RESULTS ON THE SPEECH RATE AND ARTICULATION RATE VALUES OF THE PARTICIPANTS IN SPONTANEOUS SPEECH AND READING

The arithmetic mean, standard deviation and minimum-maximum values of the speech rate and articulation rate results of all participants, those in the

youngest-old age group (65-74) and those in the middle-old age group (76-84) in spontaneous speech and reading are presented in Table 1.

DIFFERENCES IN THE SPEECH RATE AND ARTICULATION RATE VALUES OF THE PARTICIPANTS IN SPONTANEOUS SPEECH AND READING

According to the paired-sample t-test results, the speech rate of the literate participants ($n=41$) during spontaneous speech [$X=255.698$; standard deviation (SD)=33.6] was significantly higher than their speech rate during reading ($X=235.458$; SD=56.9) ($t=2.375$; SD=40; $p=0.022$; $p < 0.05$). Similarly, the articulation rate of the literate participants ($n=41$) during spontaneous speech ($X=362.203$; SD=47.7) was significantly higher than their articulation rate during reading ($X=310.472$; SD=51.0) ($t=7.428$; SD=40; $p < 0.001$).

DIFFERENCES IN THE SPEECH RATE AND ARTICULATION RATE VALUES OF THE PARTICIPANTS IN SPONTANEOUS SPEECH AND READING BASED ON THEIR AGE GROUPS

According to the paired-sample t-test results, there was no significant difference between the speech rate of the participants in the youngest-old age group (65-74) ($n=37$) during spontaneous speech ($X=257.455$; SD=33.0) and their speech rate during reading

TABLE 1: Descriptive results of the speech rate and articulation rate values of all participants, those in the youngest-old age group (65-74) and those in the middle-old age group (76-84) in spontaneous speech and reading.

Group	Task	n	Minimum	Maximum	Mean	SD
All participants	Speech rate in speaking	50	190.466	336.121	255.996	32.2
	Articulation rate in speaking	50	261.974	463.929	359.481	45.6
	Speech rate in reading	41	131.105	352.360	235.458	56.9
	Articulation rate in reading	41	214.56	424.49	310.472	51.0
65-74 years	Speech rate in speaking	43	198.233	336.121	257.797	32.0
	Articulation rate in speaking	43	270.363	463.929	363.254	45.1
	Speech rate in reading	37	131.105	352.360	240.354	57.5
	Articulation rate in reading	37	214.56	424.49	315.575	50.9
75-84 years	Speech rate in speaking	7	190.466	286.414	244.931	33.0
	Articulation rate in speaking	7	261.974	397.263	336.310	45.3
	Speech rate in reading	4	162.639	213.426	190.168	23.4
	Articulation rate in reading	4	245.86	282.38	263.264	15.2

SD: Standard deviation.

($X=240.354$; $SD=57.5$) ($t=1.926$; $SD=36$; $p=0.062$). However, the articulation rate of the participants in this group during spontaneous speech ($X=365.537$; $SD=47.1$) was significantly higher than their articulation rate during reading ($X=315.575$; $SD=50.9$) ($t=6.742$; $SD=36$; $p<0.001$).

According to the Wilcoxon test results, there was no significant difference between the speech rate of the participants in the middle-old age group during reading (negative ranks $n=3$; positive ranks $n=1$) during reading (mean rank= 2.67 ; sum of ranks= 8.00) and their speech rate during spontaneous speech (mean rank= 2.00 ; sum of ranks= 2.00) ($Z=-1.095$; $p=0.273$). Among the same participants (negative ranks $n=4$; positive ranks $n=0$), there was also no significant difference between the articulation rates during reading (mean rank= 2.50 ; sum of ranks= 10.00) and during spontaneous speech (mean rank= 0.00 ; sum of ranks= 0.00) ($Z=-1.826$; $p=0.068$).

DIFFERENCES IN THE SPEECH RATE AND ARTICULATION RATE VALUES OF ALL PARTICIPANTS IN SPONTANEOUS SPEECH AND READING BASED ON THEIR SEXES

According to the independent-samples t-test results, among all participants ($n=50$), the speech rate of the male participants during spontaneous speech ($X=262.572$; $SD=32.8$; $n=34$) was found significantly higher than that in the female participants ($X=242.021$; $SD=26.6$; $n=16$) ($t=2.188$; $SD=48$; $p=0.034$; $p<0.05$). In all participants ($n=50$), the male participants also had a significantly higher articulation rate during spontaneous speech ($X=375.322$; $SD=41.0$; $n=34$) than the female participants ($X=325.820$; $SD=36.3$; $n=16$) ($t=4.123$; $SD=48$; $p<0.001$).

Among the literate participants ($n=41$), the male participants had a significantly higher speech rate during reading ($X=248.133$; $SD=56.9$; $n=31$) than the female participants ($X=196.163$; $SD=37.0$; $n=10$) ($t=2.7$; $SD=39$; $p=0.01$; $p<0.05$). Among the same participants ($n=41$), the male participants had a significantly higher articulation rate during reading ($X=327.057$; $SD=45.9$; $n=31$) than the female participants ($X=259.058$; $SD=25.7$; $n=10$) ($t=4.444$; $SD=39$; $p<0.001$).

DIFFERENCES IN THE SPEECH RATE AND ARTICULATION RATE VALUES OF THE YOUNGEST-OLD PARTICIPANTS IN SPONTANEOUS SPEECH AND READING BASED ON THEIR SEXES

According to the independent-samples t-test results, in all participants in the youngest-old age group ($n=43$), the male participants had a significantly higher speech rate during spontaneous speech ($X=265.267$; $SD=32.8$; $n=31$) than the female participants ($X=238.500$; $SD=20.4$; $n=12$) ($t=2.624$; $SD=41$; $p=0.012$; $p<0.05$). Likewise, among the same participants ($n=43$), the male participants had a significantly higher articulation rate during spontaneous speech ($X=378.052$; $SD=41.6$; $n=31$) than the female participants ($X=325.024$; $SD=28.8$; $n=12$) ($t=4.045$; $SD=41$; $p<0.001$).

In all literate participants in the youngest-old age group ($n=37$), the male participants had a significantly higher speech rate during reading ($X=252.278$; $SD=56.0$; $n=29$) than the female participants ($X=197.128$; $SD=41.3$; $n=8$) ($t=2.585$; $SD=35$; $p=0.014$; $p<0.05$). Similarly, among the same participants ($n=37$), the male participants had a significantly higher articulation rate during reading ($X=330.709$; $SD=45.1$; $n=29$) than the female participants ($X=260.717$; $SD=28.6$; $n=8$) ($t=4.141$; $SD=35$; $p<0.001$).

DIFFERENCES IN THE SPEECH RATE AND ARTICULATION RATE VALUES OF THE MIDDLE-OLD PARTICIPANTS IN SPONTANEOUS SPEECH AND READING BASED ON THEIR SEXES

According to the Mann-Whitney U test results, among all participants in the middle-old age group ($n=7$), there was no significant difference between the speech rate results of the male participants ($X=234.727$; mean rank= 3.00 ; sum of ranks= 9.00 ; $n=3$) and the female participants ($X=252.584$; mean rank= 4.75 ; sum of ranks 19.00 ; $n=4$) during spontaneous speech ($U=3$; $Z=1.061$; $p=0.289$). Likewise, among the same participants ($N = 7$), there was no significant difference between the articulation rate results of the male participants ($X=378.052$; mean rank= 4.33 ; sum of ranks= 13.00 ; $n=4$) and the female

participants ($X=325.024$; mean rank=3.75; sum of ranks=15.00; $n=4$) during spontaneous speech ($U=5$; $Z=0.354$; $p=0.724$).

CORRELATIONS BETWEEN THE SMMSE RESULTS OF THE PARTICIPANTS AND THEIR SPEECH RATE AND ARTICULATION RATE VALUES DURING SPONTANEOUS SPEECH AND READING

The results of the correlation analyses between the SMMSE results of all participants and their speech rate and articulation rate values during spontaneous speech and reading are shown in Table 2.

No statistically significant relationship was found between the SMMSE results of all participants and their speech rate or articulation rate values during spontaneous speech or reading (Pearson's correlation analysis; $p>0.05$) (Table 2).

DISCUSSION

In this study, the principal aim was to present preliminary normative findings about the speech rate and articulation rate values of native Turkish speakers in the youngest-old and middle-old age groups during spontaneous speech and reading.

SPEECH RATE AND ARTICULATION RATE IN SPONTANEOUS SPEECH

Considering the results of all participants (ages: 65-84), the mean speech rate and articulation rate values during spontaneous speech were 255.99 S/M and 359.48 S/M, respectively. As no similar study focused on this age group within Turkish-speaking individuals could be found, the results of this study may be compared to those obtained by Cangi et al., who investigated the topic in young adults.²² While their study included university students as a particular educational group, the authors reported the mean speech rate of university students in the age group of 19-24 as 320.70 S/M, while they reported the mean articulation rate of the same group as 404.91 S/M. A study in other language also reported higher speech rate and articulation rate values in young individuals.¹⁸

Consequently, it may be stated that the speech rate and articulation rate results of the participants in this study who were in the age group of 65-84 were lower than those reported in younger individuals, as expected. These results may be explained by the fact that speech rate and articulation rate are closely associated with several skills, including linguistic, cog-

TABLE 2: Relationships between the SMMSE results of all participants and their speech rate and articulation rate values during spontaneous speech and reading.

		Standardized mini-mental state examination	Speech rate in speaking	Articulation rate in speaking	Speech rate in reading	Articulation rate in reading
Standardized Mini-Mental State Examination	r value	1	0.131	-0.044	0.233	0.150
	p value		0.365	0.761	0.142	0.348
	n	50	50	50	41	41
Speech rate in speaking	r value		1	0.671**	0.364*	0.460**
	p value			<0.001	0.019	0.002
	n		50	50	41	41
Articulation rate in speaking	r value			1	0.285	0.593**
	p value				0.071	<0.001
	n			50	41	41
Speech rate in reading	r value				1	0.882**
	p value					<0.001
	n				41	41
Articulation rate in reading	r value					1
	p value					
	n					41

* $p<0.05$; ** $p<0.01$; SMMSE: Standardized mini-mental state examination.

nitive, and motor skills, and there are regressions in these skills in the old-age period.^{5,27,28} According to researchers, lower speech rate and articulation rates in elderly individuals may be a behavioral strategy to preserve articulator precision or a compensatory action strategy to preserve the accuracy of speech in the case of reduced articulatory control, which may explain the lower speech rate and articulation rate values at advanced ages.^{11,13-15,29} In their study conducted with participants at the ages of 64-91, Sullivan reported the mean speech rate and articulation rate values during spontaneous speech in all participants, respectively, as 223 S/M and 296 S/M.³⁰ As a result of their study, which included participants over the age of 60, Andrade and Martins reported mean speech rate values of 216.94 S/M in the participants in the age group of 60-69, 201.64 S/M in those aged 70-79, 183 S/M in those aged 80-89, and 177.34 S/M in those aged 90-99.¹³ It is thought that the higher speech rate and articulation rate values of the Turkish-speaking participants of this study compared to individuals in the same age groups speaking different languages may be associated with the fact that Turkish is a syllable-timed language.^{11,13-15} It is known that Romance languages (e.g., Spanish, Italian, French), which are syllable-timed, are also spoken faster than Germanic languages (e.g., English, Dutch, German), which are stress-timed.³¹

SPEECH RATE AND ARTICULATION RATE IN READING

In this study, the mean speech rate and articulation rate values during reading among all participants were 235.45 S/M and 310.47 S/M, respectively. These values were lower than those reported in younger age groups in both Turkish and other languages.^{15,21-23} For example, İyigün et al. found the mean reading rate of participants in the 20-35 age group was 334.12 S/M while reporting a mean value of 282.71 S/M for individuals over the age of 56.²³ It is believed that the main reason for the lower reading rate results in this study in comparison to other studies was the age factor. In a way that supports this view, the mean reading rate of the youngest-old participants in this study (257.79 S/M) was significantly

higher than that of the middle-old participants (244.93 S/M).

Another important issue to consider is the discussion of the results of this study alongside the results of studies conducted with similar age groups in other languages. The higher speech rate and articulation rate observed in the Turkish-speaking participants in this study (ages: 65-84) compared to the English-speaking participants in the study by Sullivan (ages: 64-91; speech rate: 215 S/M and articulation rate: 263 S/M) could be attributed to the unique prosodic properties of Turkish, which supported this view.³⁰ In a study conducted by Trauzettel-Klosinski and Dietz, which investigated the reading rates of individuals in 17 different languages, including English and Turkish, the mean reading rates were found to be 370 S/M (SD=80) across all languages. Specifically, the reading rates were 313 S/M in English and 444 S/M in Turkish, which supported this view.³²

In this study, the mean speech rate of all participants in spontaneous speech (255.99 S/M) was significantly higher than their mean speech rate in reading (235.45 S/M), whereas their mean articulation rate in spontaneous speech (359.48 S/M) was also significantly higher than their mean articulation rate in reading (310.47 S/M). Although several studies in the relevant literature have found higher speech rate and articulation rate values in reading in comparison to spontaneous speech, other studies have not found a significant difference in these values between spontaneous speech and reading, and others have determined higher speech rate and/or articulation rate values in spontaneous speech than in reading.^{6,15,22,30,33} These differences may have been caused primarily by the fact that spontaneous speech and reading are different functions in many respects. Additionally, the shortness of the pauses in the speech rate measurements of the participants being examined or the context of measurement (e.g., speaking on the phone or the difficulty of the text) may have an effect on the results.

EFFECTS OF SEX ON SPEECH RATE AND ARTICULATION RATE IN SPONTANEOUS SPEECH AND READING

In this study, analyses based on spontaneous speech, the male participants had significantly higher mean

speech rate (262.572 S/M) and articulation rate (375.322 S/M) values than the female participants (242.021 S/M and 325.820 S/M, respectively). While the results of many studies in the relevant literature have supported the results of this study, there are also studies that have not identified a significant difference between the speech rate and/or articulation rate results of male and female participants.^{6,14,19,22} White-side, found that males had a higher articulation rate than females. They attributed this difference to the fact that females had longer average utterance durations and more frequent pauses than males.³⁷ In this study, analyses based on reading, the male participants also had significantly higher mean speech rate (248.133 S/M) and articulation rate (327.057 S/M) values than the female participants (196.163 S/M and 259.058 S/M, respectively). Although the results of a study conducted by Lee and Doherty with Irish English speakers agreed with the results of this study, many studies in the literature have reported that speech rate and/or articulation rate values in reading do not differ significantly between the sexes.^{18,22,23}

CONCLUSION

In conclusion, in this study, it was seen that the speech rate and articulation rate results of participants in the youngest-old and middle-old age groups in spontaneous speech and reading were lower in comparison to those reported in several other studies conducted with younger individuals in Turkish and other languages. Furthermore, the speech rate and articulation rate results of the participants in this study in spontaneous speech and reading were higher than the results reported in studies conducted in stress-timed languages. Finally, the speech rate and articulation rate results of the male participants in this study in

spontaneous speech and reading were higher than those of the female participants. The results of this study may be taken as a reference for the examination, treatment planning, and result interpretation of individuals in the youngest-old and middle-old age groups in many respects, including language, cognition, and motor capacities.

To enhance the quality of normative research in future studies, researchers should consider using larger and more carefully selected samples with diverse demographic characteristics. Additionally, they can incorporate various factors like cognitive processes, motor and sensory states, while controlling for linguistic complexity, word frequency, sentence length, and emotional state to explore their effects.

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

Authorship Contributions

Idea/Concept: Mehmet Emrah Cangi; **Design:** Mehmet Emrah Cangi, İlayda Gündüz; **Control/Supervision:** Mehmet Emrah Cangi; **Data Collection and/or Processing:** İlayda Gündüz; **Analysis and/or Interpretation:** Mehmet Emrah Cangi, İlayda Gündüz; **Literature Review:** Mehmet Emrah Cangi, İlayda Gündüz; **Writing the Article:** İlayda Gündüz; **Critical Review:** Mehmet Emrah Cangi.

REFERENCES

1. Sturm JA, Seery CH. Speech and articulatory rates of school-age children in conversation and narrative contexts. *Lang Speech Hear Serv Sch*. 2007;38(1):47-59. PMID: 17218535.
2. Costa LM, Martins-Reis Vde O, Celeste LC. Methods of analysis speech rate: a pilot study. *Codas*. 2016;28(1):41-5. English, Portuguese. PMID: 27074188.
3. Amir O, Grinfeld D. Articulation rate in childhood and adolescence: Hebrew speakers. *Lang Speech*. 2011;54(Pt 2):225-40. PMID: 21848081.
4. Darling-White M, Sakash A, Hustad KC. Characteristics of speech rate in children with cerebral palsy: a longitudinal study. *J Speech Lang Hear Res*. 2018;61(10):2502-15. PMID: 30286232; PMCID: PMC6428239.
5. Yuan J, Liberman M. Robust speaking rate estimation using broad phonetic class recognition, 2010 IEEE International Conference on Acoustics, Dallas, TX, USA: Speech and Signal Processing; 2010. p.4222-5, doi: 10.1109/ICASSP.2010.5495686.
6. Jacewicz E, Fox RA, O'Neill C, Salmons J. Articulation rate across dialect, age, and gender. *Lang Var Change*. 2009;21(2):233-56. PMID: 20161445; PMCID: PMC2790192.
7. Berry J. Speaking rate effects on normal aspects of articulation: outcomes and issues. *Perspectives On Speech Science And Orofacial Disorders*. 2011;21(1):15-26. <https://doi.org/10.1044/ssod21.1.15>
8. Topbaş O, Orlikoff RF, Louis KOS. The Effect of syllable repetition rate on vocal characteristics. *Journal of Communication Disorders*. 2012;45(3):173-80. <https://doi.org/10.1016/j.jcomdis.2012.02.001>
9. Dromey C, Ramig LO. Intentional changes in sound pressure level and rate: their impact on measures of respiration, phonation, and articulation. *J Speech Lang Hear Res*. 1998;41(5):1003-18. PMID: 9771624.
10. Hegde MN. *Hegde's Pocketguide to Communication Disorders*. 2nd ed. San Diego, CA: Plural Publishing; 2018. https://www.pluralpublishing.com/application/files/6115/4700/0937/media_hpgtstp4e_SamplePages.pdf
11. Ramig LA. Effects of physiological aging on speaking and reading rates. *J Commun Disord*. 1983;16(3):217-26. PMID: 6875037.
12. Smith BL, Wasowicz J, Preston J. Temporal characteristics of the speech of normal elderly adults. *J Speech Hear Res*. 1987;30(4):522-9. PMID: 3695445.
13. Andrade CR, Martins Vde O. Speech fluency variation in elderly. *Pro Fono*. 2010;22(1):13-8. English, Portuguese. PMID: 20339802.
14. Verhoeven J, De Pauw G, Kloots H. Speech rate in a pluricentric language: a comparison between Dutch in Belgium and the Netherlands. *Lang Speech*. 2004;47(Pt 3):297-308. PMID: 15697154.
15. Duchin SW, Mysak ED. Disfluency and rate characteristics of young adult, middle-aged, and older males. *J Commun Disord*. 1987;20(3):245-57. PMID: 3597824.
16. Block S, Killen D. Speech rates of Australian English-speaking children and adults. *Australian Journal of Human Communication Disorders*. 1996;24(1):39-44. <https://doi.org/10.3109/asl2.1996.24.issue-1.05>
17. Hall KD, Amir O, Yairi E. A longitudinal investigation of speaking rate in pre-school children who stutter. *J Speech Lang Hear Res*. 1999;42(6):1367-77. PMID: 10599619.
18. Lee A, Doherty R. Speaking rate and articulation rate of native speakers of Irish English. *Speech, Language and Hearing*. 2017;20(4):206-11. <https://doi.org/10.1080/2050571X.2017.1290337>
19. Robb MP, Maclagan MA, Chen Y. Speaking rates of American and New Zealand varieties of English. *Clinical Linguistics & Phonetics*. 2004;18(1):1-15. <https://doi.org/10.1080/0269920031000105336>
20. Tauroza S, Allison D. Speech rates in British English. *Applied Linguistics*. 1990;11(1):90-105. <https://doi.org/10.1093/applin/11.1.90>
21. Venkatagiri HS. Clinical measurement of rate of reading and discourse in young adults. *Journal of Fluency Disorders*. 1999;24(3):209-26. [https://doi.org/10.1016/S0094-730X\(99\)00010-8](https://doi.org/10.1016/S0094-730X(99)00010-8)
22. Cangı ME, Işıldar A, Tekin A, Saraç AB. A preliminary study of normative speech rate values of Turkish speaking adults. *ENT Updates*. 2020;10(3):381-9. <https://doi.org/10.32448/entupdates.769051>
23. İyigün E, Bekircan M, Maviş İ. Yetişkin bireylerde yaş, eğitim ve cinsiyet değişkenlerinin okuma hızına etkisi [Effects of age, education and gender on reading speed of adults]. *Dil, Konuşma ve Yutma Araştırmaları Dergisi*. 2018;1(2):162-78.
24. TÜİK [Internet]. İstatistiklerle Yaşlılar, 2020. Erişim linki: <https://data.tuik.gov.tr/Bulten/Index?p=İstatistiklerle-Yasliilar-2020-37227> (Erişim tarihi eklenmelidir.)
25. Güngen C, Ertan T, Eker E, Yaşar R, Engin F. Standardize Mini Mental test'in türk toplumunda hafif demans tanısında geçerlik ve güvenilirliği [Reliability and validity of the standardized Mini Mental State Examination in the diagnosis of mild dementia in Turkish population]. *Türk Psikiyatri Derg*. 2002;13(4):273-81. Turkish. PMID: 12794644.
26. Boersma P, Van Heuven V. Speak and unSpeak with PRAAT. *Glott International*. 2001;5(9):341-7. https://www.researchgate.net/publication/303164808_Speak_and_unSpeak_with_PRAAT
27. Goozée JV, Stephenson DK, Murdoch BE, Darnell RE, Lapointe LL. Lingual kinematic strategies used to increase speech rate: comparison between younger and older adults. *Clin Linguist Phon*. 2005;19(4):319-34. PMID: 16019978.
28. Lickley RJ. Fluency and Disfluency. In M. Redford ed. *The Handbook of Speech Production*. 1st ed. New Jersey: Wiley-Blackwell; 2015. p.445-69. <https://doi.org/10.1002/9781118584156.ch20>
29. Fletcher AR, McAuliffe MJ, Lansford KL, Liss JM. The relationship between speech segment duration and vowel centralization in a group of older speakers. *The Journal of the Acoustical Society of America*. 2015;138(4):2132-9. <https://doi.org/10.1121/1.4930563>
30. Sullivan LS. *Speech And Articulation Rates Of Older New Zealand Adults* [Master's thesis]. New Zealand: University of Canterbury; 2016. <https://ir.canterbury.ac.nz/server/api/core/bitstreams/f83d95c5-0106-4feb-be9c-7ab9707c70b3/content> (Erişim tarihi eklenmelidir.)
31. Arvaniti A, Rodriquez T. The role of rhythm class, speaking rate, and F0 in language discrimination. *Laboratory Phonology*. 2013;4(1):7-38. <https://doi.org/10.1515/lp-2013-0002>
32. Trauzettel-Klosinski S, Dietz K; IReST Study Group. Standardized assessment of reading performance: the New International Reading Speed Texts IReST. *Invest Ophthalmol Vis Sci*. 2012;53(9):5452-61. PMID: 22661485.
33. Howell P, Kadi-Hanifi K. Comparison of prosodic properties between read and spontaneous speech material. *Speech Communication*. 1992;10(2):163-9. [https://doi.org/10.1016/0167-6393\(91\)90039-V](https://doi.org/10.1016/0167-6393(91)90039-V)
34. Toth L, Hoffmann I, Gosztolya G, Vincze V, Szatloczki G, Banreti Z, et al. A speech recognition-based solution for the automatic detection of mild cognitive impairment from spontaneous speech. *Curr Alzheimer Res*. 2018;15(2):130-8. PMID: 29165085; PMCID: PMC5815089.
35. Hoffmann I, Nemeth D, Dye CD, Pákási M, Irinyi T, Kálmán J. Temporal parameters of spontaneous speech in Alzheimer's disease. *Int J Speech Lang Pathol*. 2010;12(1):29-34. PMID: 20380247.
36. World Health Organization. *World Report on Ageing and Health*. Geneva: Who Press; 2015. https://iris.who.int/bitstream/handle/10665/186463/9789240694811_eng.pdf?sequence=1&isAllowed=y
37. Whiteside SP. Temporal-based acoustic-phonetic patterns in read speech: some evidence for speaker sex differences. *Journal of the International Phonetic Association*. 1996;26(1):23-40. <https://doi.org/10.1017/S0025100300005302>