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COMPARISONOFPERSIANLANGUAGEFRICATIVECONSONANTSRECOGNITIONINBABBLENOISEINFOURTHANDFIFTHDECADESOFLIFE

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Comparison of Persian Language Fricative Consonants Recognition in Babble Noise in Fourth and Fifth Decades of Life

Zahra Sharafi [α], Ali Mohammadzadeh [σ], Majid Ashrafi [ρ] & Firoozeh Z. Mohamdzadeh [Ѡ]

Abstract- Generally, regular communications are performed in the presence of noise. Babble noise imposes a negative impact on the speech signal by its nature. Consonants play a vital role in the perception of the word meaning. From presented samples, sixty adults with normal hearing were assessed in this cross-sectional study. Once auditory and speech assessment was performed, the recognition of fricative consonants as a consonant-vowel-consonant syllable in babble noise was compared in two age groups of 30-39 and 40-49 years old in signal-to-noise ratios of 0, and -5. In the occurrence of certain vowels in 0 and -5 signal-to-noise ratios, there was a significant difference between the two age groups of 30-39 and 40-49 years old considering the recognition score of fricative consonants. The recognition score of fricative consonants was affected by age, signal-to-noise ratio, and concurrent vowel. Also, the recognition scores of sibilant fricative consonants were greater in the babble noise in two age groups.

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I. Introduction

Daily communication often takes place in the presence of interfering factors, such as noise (Fogerty, Bologna, Ahlstrom, & Dubno, 2017). Noise in the auditory environments with masking low-level parts of the signal, obscuring it, and ultimately decreasing speech perception (Rogers, Lister, Febo, Besing, & Abrams, 2006). Different types of noise have unique masking effects (Lecumberri & Cooke, 2006). Speech perception in the presence of noise is a complex process that is affected by several factors (Woods, Yund, Herron, & Cruadhlaoich, 2010). Aging can affect signal processing in speech and hearing domains, and the decrease in speech perception in a noisy environment is the most obvious manifestation of it (Pichora-Fuller & Singh, 2006).

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Speech phonemes are divided into consonants and vowels (Stilp & Kluender, 2010). Consonants provide important cues for speech perception (Fogerty & Humes, 2010). In the discrimination procedure, the temporal and frequency content provided with fricative consonants (roughly above 1500 Hz) is essential (F. Li, Trevino, Menon, & Allen, 2012); it is particularly significant when the target signal should be realized in degraded auditory environments (N. Li & Loizou, 2008). A fricative is produced when the vocal tract is constricted somewhere along its long enough to produce a noisy sound when air is forced through the constriction (Shadle, 1985).

Persian has eight fricative consonants, which were classified into two classes of voiced (z, ʒ, v) and voiceless (s, ʃ, f, x, h) (Alinezhad & Hosseini-Balam, 2012). When voiced fricative consonants are created as compared with their voiceless counterparts, the pharyngeal volume is higher (Proctor, Shadle, & Iskarous, 2010). The articulation place of /z/, /s/ is alveolar, /ʒ/, /ʃ/ is alveopalatal, /f/, /v/ is labiodental, /x/ is velar, and /h/ is glottal (Alinezhad & Hosseini-Balam, 2012). The subclasses of fricative sounds are /s/, /z/, /ʃ/, /ʒ/ that termed as "sibilant sounds" for their sibilant nature and also the sounds /v/, /x/, /h/, /f/ termed as non-sibilant (Ryalls, 1996).

In the perception of fricative consonants in noise, multiple factors are important (Nittrouer, Miller, & Manhart, 2000). The duration of fricative consonants is affected by a concomitant vowel (Whitehead, Schiavetti, Metz, & Farinella, 1999). Persian has 6 vowels /i/, /e/, /a/, /â/, /o/, and /u/. They were classified as front and back vowels based on the articulation place (Sharafi, Mohammadzadeh, Tabatabaee, & Hamzehpour, 2020). The place articulation of front vowels, which consist of /e/, /i/, and /a/, is the anterior part of the mouth, and that of back vowels /o/, /u/, and /â/ is the posterior part of the mouth (Alinezhad & Hosseini-Balam, 2012). Also, the formant transition plays a key role in the identification of some fricative consonants. Information carried with formant transition has a vital role in the identification process (Fogerty & Humes, 2010).

Age-related changes in the regulation of inhibitory and excitatory processes can lead to perceptual problems in the middle-aged and elderly population (Tremblay, Piskosz, & Souza, 2003). To assess the effects of age on speech recognition in noise, most studies looked at elderly people. However, not only the elderly but also middle-aged adults reported complaints of communication problems in the presence of background noise. For example, in a study performed by Lee et al. (Lee et al., 2015) eighteen young adults with normal hearing (with a mean age of 24.42 years old) and fifteen middle-aged adults with normal hearing (with a mean age of 48.30 years) were evaluated and the word recognition was assessed in quiet and then in noise. The results showed that middle-aged adults have a lower ability in speech recognition in noise compared to young adults. In addition, the study conducted by Grose et al. (Grose, Hall III, & Buss, 2006) showed that temporal processing deficits in the auditory system are evident in middle-aged people.

However, the question brings up whether poor hearing processing of middle-aged people compared to young people can reduce the fricative consonants recognition in babble noise. Also, if we assume that the Persian fricative consonants recognition is weaker in middle-aged adults compared to young adults. We need to know which consonants are more vulnerable to the effects of age in the presence of noise.

II. Material and Methods

In Audiology Clinic of school Rehabilitation, the current observational and cross-sectional investigation was conducted on sixty adults with normal hearing (thirty people aged 30 to 39 years old with mean age and standard deviation (SD) of 33.40±2.35 years and thirty aged 40 to 49 years with mean age and SD of 44.73±2.33 years). In this study, participants were selected on-random. All participants signed informed consent statements and completed a case history type to make certain that there are no records on auditory and neurological concerns before the experiment. In the research, all subjects were observed in the following situation: Persian-speaking, monolingual, right-handed (relying on the Edinburg questionnaire for handedness), normal otoscopic results, normal auditory threshold (equivalent or better than 15 dB HL in the frequency array of 500 to 8000 HZ), normal two-syllable word recognition threshold (SRT), the middle ear normal functioning (with An type of tympanometry i.e., SC. 0.3 to 1.6 and MEP. -100 to +50 dapa; ipsilateral and contralateral acoustic reflexes in frequencies of 500-4000 Hz 85-100 dB SPL), no crucial auditory processing disorder (relying on the history of Binaural Masking Level Difference (MLD) and Central Auditory Processing Disorder (CAPD) tests to make sure the brainstem health, as well as Duration Pattern Sequence test (DPST) to guarantee the temporal cortex health). The phonetic experiment was further conducted to guarantee speech production health. An AC30 two-channel audiometer along with an AT235 tympanometer made by Denmark Interacoustic Company was applied for the auditory assessments. 73 monosyllabic words of CVC were selected with a fricative consonant. These words were recorded by a specialized voice actor in the recording studio, the interval time for responding by written matter was established as 4 seconds. A stimulus random performance in quiet and two signal-to-noise ratios of 0, and -5 via the TDH-39 headphone made by Telephonix Company in the USA were provided in this study. The test's final version was provided by the Ideapad 310 core i7 Lenovo laptop (made in China) and transmitted to the Interacoustic AC30 audiometer (made in Denmark) once the calibration was done. Each person was at the outset provided with a thorough description of how the experiment is conducted. The stimuli presentation in quiet together with babble noise in two signals to noise ratios of 0, and -5 further were presented in the right ear by the random. For intensity regulation, a sinusoidal noise with a frequency of 1000 Hz was provided ten seconds before the first word presentation. A randomized performance of syllables together with rest periods between each phase was also applied to evade recalling the words. For each individual, at the final point, the recognition Score of fricative consonants was estimated and documented in the sheet. For statistical data analysis at a significant level of 0.05, the SPSS software version 19 was used. To compare the mean values of auditory thresholds and the recognition scores of fricative consonants in two age groups, the Mann-Whitney technique was applied. For comparing consonant recognition scores in two signal-to-noise ratios of 0, and –5, the Wilcoxon test was used.

III. Results

There were no significant differences between the two age groups in the mean of auditory threshold values (P= 0.433). In both groups, the mean recognition score of fricative consonants declined significantly by increasing the noise level (p = 0.001). However, middle-aged people compared to young people showed a significant decrease in signal-to-noise ratios of 0 and -5 (p = 0.001). In signal-to-noise ratios of 0, and -5, the mean recognition score of /ʃ/ consonant was higher than other ones in both age groups (Table 1). The Mann-Whitney test defined that the recognition score of the /s/, /z/, /ʃ/, /v/, /f/, /h/ consonants in the signal-to-noise ratio of 0 and the /s/, /z/ /v/, /f/, /h/ ones in the signal-to-noise ratio of -5 differ significantly in two age groups (Table 1).

In different vowels, the mean recognition score of fricative consonants differs between the two age groups. The fricative consonants in the signal-to-noise ratio of 0 had the highest mean score with vowel /a/ in the age group 30 to 39 and with vowel /i/ in the group 40 to 49 years old. Fricative consonants in the signal-to-noise ratios of -5, had the highest mean score with vowel /i/ in two age groups 30 to 39 and 40 to 49 years. The lowermost mean recognition score of fricative consonants has been shown with the vowel /o/ in two signal-to-noise ratios of 0, and -5 in both age groups (Figures 1, 2).

Via Mann-Whitney test, it was revealed that in the presence of /u/, /o/, /â/, /a/, /i/, /e/ vowels in the signal-to-noise ratio of 0 and /e/, /a/, /u/, /o/vowels in the signal to noise ratio of -5, the recognition score of fricative consonants differs significantly in two age groups (Table 2).

IV. Discussion

The recognition of fricative consonants in the babble noise was compared in two age groups in this research. The results showed that in the presence of babble noise, the recognition score of younger adults was better. The recognition score of fricative consonants also declines by the decrease in signal-to-noise ratio (SNR) in both age groups. this is in line with the findings of research by Sharafi et al (Sharafi, Mohammadzadeh, Sharifian, & Tabatabaee, 2019), Lee et al (Lee et al., 2015). The present study showed that the recognition scores of fricative consonants decline as age grows; this is inconsistent with the findings of the research by Kalaiah et al (Kalaiah, Thomas, Bhat, & Ranjan, 2016). Kalaiah et al. claim that middle-aged adults experience more perceptual difficulties than young adults. The findings of studies by Yilmaz et al (Yılmaz, Sennaroğlu, Sennaroğlu, & Köse, 2007)., Helfer et al (Helfer & Vargo, 2009)., and Lee et al (Lee et al., 2015), also revealed that in the presence of noise, speech recognition declines as age grows.

It may be concluded, from investigations that revealed the age impact on the speech recognition ability in noise, that the lower speed in speech processing, the reductions in the central auditory processing abilities, and supra-threshold processing in middle-aged adults as compared to youth (Ben-David, Vania, & Schneider, 2012) result in decreases in temporal encoding, information storage skill, and finally disorders in speech perception in noise. While the trouble in retrieving words arises at any age, commonly it appears to rise with age growth (Kortlang, Mauermann, & Ewert, 2016). The capability to apply acoustic cues for people because of impairment in temporal resolution and temporal fine-structure coding may be restricted by Supra threshold deficits in temporal and spectral domains (Bernstein & Oxenham, 2006).

The results of the present study revealed that the recognition score of sibilant consonants /s/, /z/, and /ʃ/ are greater than non-sibilant consonants /f/, /v/, /x/, /h/. This may be because of the longer duration in the /s/, /z/, /ʃ/ consonants.

Phatak et al. by examining 24 people, in the background noise with the same level, suggest that while the alveolar /s/, /z/ and the alveopalatal /ʃ/ consonants hardly come across with error in more than half of the cases, the recognition of non-sibilant fricative /f/, /v/, /x/, /h/ take place with error (Phatak, Lovitt, & Allen, 2008). In other words, the /v/, /x/, /h/, /f/ consonants hold lower recognition scores and /s/, /z/, /ʃ/ ones hold higher scores; this is in agreement with the present study.

With the concurrent vowel, the sound features of the consonants may be varied (Whitehead et al., 1999). It can be stated; indeed, the concurrent vowel may have an impact on the recognition of fricative consonants. In the present study, with the front vowels, the mean recognition score of the fricative consonants was better than the back ones. Further, the mean recognition score with the /i/ vowel was the highest. The research by Whitehead et al. revealed that the vowel context has a momentous impact on the fricative consonant duration. If the vowel after fricative consonants /s/ and /ʃ/ be a front vowel, they will have a long duration (Whitehead et al., 1999). Probably the longer duration of the fricative consonants with the front vowels has increased their recognition scores.

V. Conclusions

The current research revealed that the recognition score of fricative consonants in the presence of babble noise differs significantly between the fourth and fifth decades of life. The results of the work also revealed, in the presence of babble noise, the recognition score of sibilant consonants is higher. Consequently, on the recognition of Persian fricative consonants in the presence of babble noise, age and SNR are efficient factors and may result in a verbal communication disorder.

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Table 1: Mean ± Standard Deviation (SD) of the recognition scores of fricatives consonants in two signals to noise ratios of 0, and -5 in two age groups 30-39 and 40-49 years old.

SNR	Consonant	Age Groups		*P-value
		30-39	40-49	
0	/s/	20.40±1.95	19.37±2.36	*0.014
-5		16.47±4.18	13.67±3.59	*0.008
0	/z/	23.44±0.81	22.07±1.31	*0.001
-5		19.87±2.88	17.63±3.58	*0.017
0	/ʃ/	24.70±1.36	23.50±1.71	*0.004
-5		21.77±3.51	20.53±2.82	0.090
0	/x/	14.00±3.37	12.43±2.51	0.091
-5		9.87±4.36	8.90±2.42	0.431
0	/f/	12.93±1.81	8.97±2.52	*0.001
-5		8.83±3.13	5.80±2.42	*0.001
0	/v/	5.30±1.55	3.43±1.73	*0.001
-5		3.63±2.44	2.30±1.46	*0.026
0	/h/	11.70±2.73	7.23±2.56	*0.001
-5		7.20±3.99	4.37±2.35	*0.005

Table 2: Comparison of the recognition score of fricative consonants in the presence of different vowels between two age groups

SNR \ vowel	/i/	/e/	/a/	/â/	/o/	/u/
0	*0.002	*0.002	*0.001	*0.001	*0.001	*0.001
-5	0.117	*0.020	*0.008	0.059	*0.005	*0.002

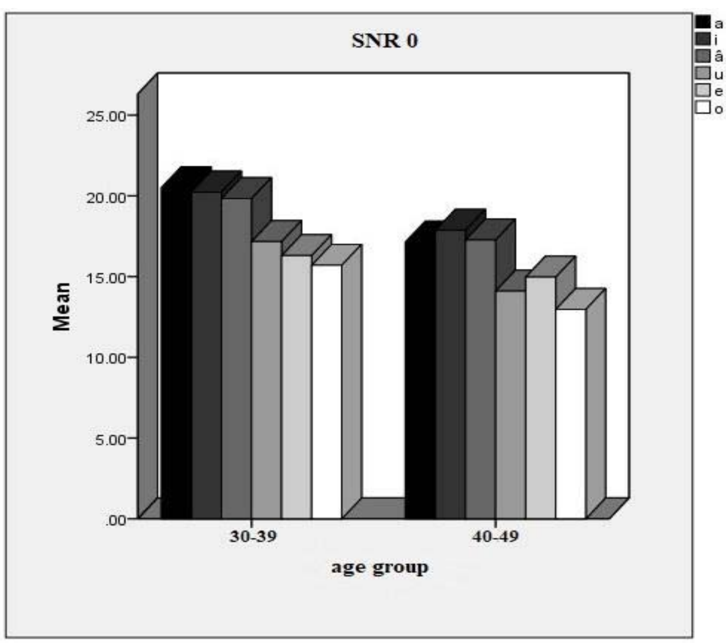

Figure 1: The mean recognition scores of fricative consonants in Signal to noise ratio of 0 in two age groups, in the presence of six Persian vowels.

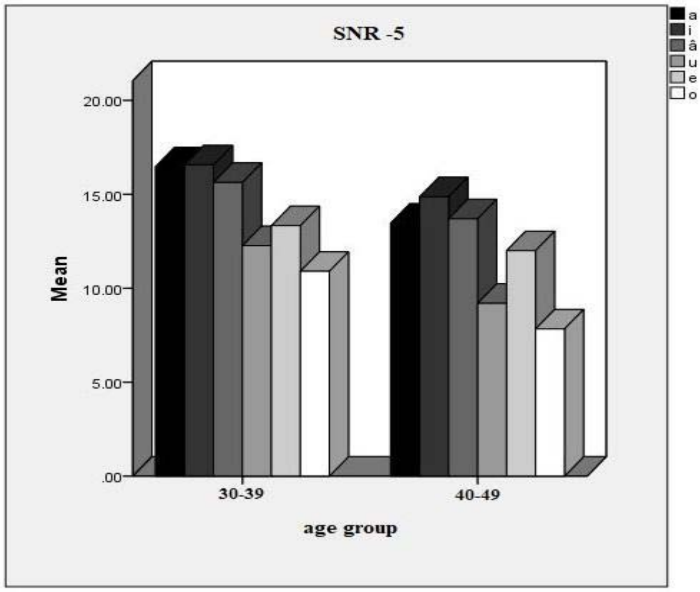

Figure 2: The mean recognition scores of fricative consonants in Signal to noise ratio of -5 in two age groups, in the presence of six Persian vowels.