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RESEARCH ARTICLE

Evaluation of speech perception in noise in Kurd-Persian bilinguals

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Abstract

Background and Aim: In most everyday settings, speech is heard in the presence of competing sounds and speech perception in noise is affected by various factors, including cognitive factors. In this regard, bilingualism is a phenomenon that changes cognitive and behavioral processes as well as the nervous system. This study aimed to evaluate speech perception in noise and compare differences in Kurd-Persian bilinguals versus Persian monolinguals.

Methods: This descriptive-analytic study was performed on 92 students with normal hearing, 46 of whom were bilingual Kurd-Persian with a mean (SD) age of 22.73 (1.92) years, and 46 other Persian monolinguals with a mean (SD) age of 22.71 (2.28) years. They were examined by consonant-vowel in noise (CV in noise) test and quick speech in noise (Q-SIN) test. The obtained data were analyzed by SPSS 21.

Results: The comparison of the results showed differences in both tests between bilingual and monolingual subjects. In both groups, the reduction of signal-to-noise ratio led to lower scores, but decrease in CV in noise test in bilinguals was less than monolinguals ($p < 0.001$) and in the Q-SIN test, the drop in bilinguals' score was more than monolinguals ($p = 0.002$).

Conclusion: Kurd-Persian bilinguals had a better performance in CV in noise test but had a worse performance in Q-SIN test than Persian monolinguals.

Keywords: Kurd-Persian; bilingual; monolingual; quick speech in noise test; consonant vowel in noise test; speech perception in noise

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Introduction

Speech perception in noise requires complex interaction between the auditory system and cognitive skills (such as attention and memory) in the central nervous system in order to differentiate between target sound and competing noise [1]. In fact, speech perception in noise is one of the most complex auditory tasks that listeners encounter with.

From one point of view, speech perception in noise takes place through two types of processing: 1) acoustic signal processing or bottom-up processing, and 2) cognitive-language processing or top-down processing. In other words, speech perception in noise depends on the interaction between sensory and cognitive processing

[1]. Cognitive processing can be influenced by different factors and bilingualism is one of these environmental factors affecting cognition [2]. Nowadays bilingualism is increasing in such a manner that half of the people around the world are bilinguals [3]. Bilinguals and multi-linguals are people who commonly use two or more languages in everyday life and are able to produce and understand two or more languages [2]. As speech perception in noise is affected by the cognitive process [4], it is expected that bilingualism affects speech perception in noise.

More powerful subcortical encoding in bilinguals has been proven in previous studies [5,6]. Researchers have shown that bilinguals have stronger evoked responses to speech (in speech ABR with frequency following-like responses), F0 encoding, and more stable response during testing than monolinguals [7]. In these studies, researchers evaluated speech perception in noise in bilinguals [8-10].

Onoda et al. compared temporal processing and dichotic listening in bilinguals and monolinguals. They used dichotic digits test (DDT), disyllable dichotic test (for unfamiliar words), staggered spondaic word (SSW), frequency pattern test (FPT), and duration pattern test (DPT). There were not any differences between two groups in DPT and DDT, but FPT test score was higher in bilinguals than monolinguals. In addition, SSW score was specifically affected by bilingualism and bilinguals had a higher score than monolinguals [11] and this finding is justifiable by greater volume of corpus callosum [12]. Weiss and Dempsey evaluated two bilingual groups. They used English and Spanish hearing in noise test (HINT) in sound field at four different test conditions: presenting sentences without competing noise, with competing noise from front, 90° right, and 90° left positions. Target sentences are always presented at 0° azimuth. All participants showed a higher score at Spanish HINT than English one in all presentation conditions [13].

Lucks Mendel, and Widner also studied speech perception in noise in normal hearing bilinguals. Participants consisted of Spanish-English bilinguals and English monolinguals. The study tests were the word in noise (WIN), quick speech in noise (Q-SIN) and Bamford-Kowal-Bench (BKB-SIN). Within each group, the scores of WIN and Q-SIN tests were comparable but scores of these two tests were lower than BKB-SIN in both groups. Q-SIN and WIN scores in bilinguals were lower than monolinguals. The limitation of their study was the wide age range of the participants (18 to 58 years old), because in spite of normal hearing level (20 dB HL) of all participants, biologic and cognitive involvements with age is an irrefutable fact. In addition, participants had learned the second language at different ages; therefore the duration of experiencing the second language was different from each other and could be accounted as a confounding variable, too [9].

Based on the above-mentioned results, we decided to investigate speech perception in noise for Kurd-Persian bilinguals and compare the results with previous studies. CV in noise and Q-SIN tests were selected to be performed in 18 to 25 years old students to control any age effects. As CV in noise test consists of short and non-sense speech materials with low language load, this test is not highly dependent on syntax, semantic, and background characteristics and its focus is mostly on bottom-up signal processing pathways. In fact, this test is suitable to exclude language cues as confounding effects, increase the contribution of acoustic aspects of the signal, and more accurate evaluation of ascending pathways involved in speech processing [14]. Furthermore, in this test attention and memory involvement would be low [15].

Q-SIN test is a fast test (1-2 minutes), has high reliability, an easy scoring method (based on the correctly recognized words in the sentence), background noise type (multi-talker noise for more realistic simulation of the real conditions), variability of SNRs, and selection of keywords to represent real life stimuli [8,16].

Methods

This is a descriptive-analytic study on 92 University students, aged 18 to 25 years, including 46 Kurd-Persian bilinguals and 46 Persian monolinguals. All bilinguals had learned Persian

after Kurdish (native language) and learned it before 7 years old.
The samples were collected by available sampling methods. At first, the test procedure was explained to the subjects and an informed consent was obtained from each subject. Then Edinburg handedness test was administered to verify right-handedness. Next, for hearing evaluation, pure tone audiometry (20 dB HL or lower hearing threshold at octave frequencies 250 to 8000 Hz in both ears) by using Midimate 622 audiometer (GN Otometrics, Denmark), speech audiometry (word recognition score in quiet more than 92% in both ears), acoustic immittance audiometry (A tympanogram defined as peak pressure +50 to −50 daPa, static compliance 0.27–1.38 and ear canal volume of 0.63–1.46 cm^3 [17] in addition to presence of acoustic reflex at four ipsilateral frequencies, including 0.5, 1, 2 and 4 kHz and three contralateral frequencies 0.5, 1 and 2 kHz [18]) by using Zodiac 901 (Madsen, Denmark) were used. Finally right-handed individuals with normal hearing included in the study for administering CV in noise and Q-SIN tests. In this study, Persian CV in noise, developed by Lotfi et al., was used. It includes non-sense monosyllabic materials in a form of 4 lists each include 25 syllables. Syllables were presented at different SNRs including –6, –12, 0, +6 and +12 dB. A non-sense syllable with white noise presented simultaneously to one ear and it was asked to repeat what was heard. The number of correct responses, then, was calculated for each individual [14]. Persian Q-SIN, developed by Moosavi et al., includes two instructional lists and three test lists. Noise is a multi-talker one. Each list includes 6 sentences and each sentence has 5 keywords which are presented ipsilaterally with noise at different SNRs (0, +5, +10, +15, +20 and +25 dB). Then it is asked to repeat sentences. The number of the correct words is subtracted from 27.5 in each list (Q-SIN SNR loss = 27.5 – Number of correct words) [1].
Bilinguals in the present study were Kurd-Persian who had learned Persian after Kurdish and before 7 years of age (based on their personal reports). All subjects had Kurdish language with Sorani dialect which is typical for Kurdish population of West Azerbaijan, parts of Kurdistan and Kermanshah provinces.
SPSS 21 was used for descriptive and inferential analyses. For checking the normal distribution of data, Shapiro-Wilk test was used. The test showed that data did not have normal distribution so nonparametric tests were used. For analyzing variance homogeneity, Levene's test was used.

Results

In the present study, bilinguals (23 females and 23 males) had an age range of 18 to 25 years old with a mean (SD) age of 22.73 (1.92) years. Monolinguals (23 males and 23 females) had the same age range with a mean (SD) age of 22.71 (2.28) years.
Table 1 summarizes mean and standard variations of CV in noise score in both groups for each SNR separately. Comparing results by Mann-Whitney test showed a significant difference between two groups at SNRs of 0, –6 and –12 dB ($p < 0.001$). At SNR +6, there was not any significant difference between the two groups. Results of monolinguals in the present study is in agreement with the normative data of Q-SIN and CV in noise which was obtained from Persian monolinguals, but results of many bilinguals were not in this normative range which is due to the difference between monolinguals and bilinguals, so this difference was clinically significant ($p < 0.001$). Table 1 presents mean and standard deviation of Q-SIN SNR loss results of both groups. Comparing results by Mann-Whitney test showed a significant difference between the two groups ($p = 0.002$).
Comparing right and left ear scores showed no significant difference in mean scores of CV in noise and Q-SIN SNR loss. In addition, there was not any significant difference between females and males' scores in CV in noise and Q-SIN test.

Discussion

CV in noise results showed that bilinguals had a significantly higher score than monolinguals.

Table 1. Mean (standard deviation) scores of consonant-vowel and quick speech in noise tests in Persian monolingual and Kurd-Persian bilingual groups

		Mean (SD) score		
Tests	**SNR**	**Monolinguals (n = 46)**	**Bilinguals (n = 46)**	**p**
CV in noise	+6	24.66 (0.5)	24.11 (1.08)	0.007
	0	18.13 (1.13)	20.09 (2.30)	<0.001
	−6	12.80 (1.83)	16.40 (2.44)	<0.001
	−12	7.96 (1.20)	10.30 (1.40)	<0.001
Q-SIN SNR loss		−1.03 (0.60)	−0.63 (0.92)	0.002

SNR; signal to noise ratio, CV in noise; consonant-vowel in noise, Q-SIN; quick speech in noise

This score difference was seen at SNRs of 0, –6, –12 dB. This is indicative of bilingualism effects on non-sense-speech perception in noise.

There are few studies on non-sense syllable perception and these studies are mostly based on auditory brainstem response to complex sounds or speech ABR. Brainstem responses to syllables presented during this test require pitch, duration, and timber transmission in the nervous system [19,20]. In addition, studies on subcortical plasticity with non-sense syllables (/da/) showed that bilinguals have stronger encoding than monolinguals [5,6,21]. This stronger encoding of F0 is a known characteristic of pitch perception [6]. All of these studies show that electrophysiological basis for better perception of the non-sense syllables in noise in bilinguals is available at CNS. These studies have used objective tools but the present study used subjective tests. However, the results of the present study are in agreement with objective studies [6,21]. In the present study, there was a significant difference in Q-SIN score between monolinguals and bilinguals in such a manner that monolinguals had higher scores. In this test, list numbers 2 and 3 that were equivalent based on validity and reliability, were used for left and right ear. Each list had six sentences and was presented in 6 SNRs. Sentences 1 to 4 had SNRs of +25, +20, +15 and +10 and were intelligible for all participants. On the other hand, bilinguals at SNRs +5 and 0, and monolinguals at SNR 0 had some mistakes in recognizing keywords or missing some of them completely. In both groups, there were subjects who showed complete score but in general and based on statistical analysis bilinguals had lower performance at Q-SIN. Validity and test-retest reliability of Q-SIN and CV in noise in 18 to 25 years old monolinguals were confirmed at Moosavi et al. [1] and Lotfi et al. [14]. In this cross-sectional study, it was not necessary to check test-retest reliability and only inter-group comparison was made. However, Q-SIN score in monolinguals was from –0.5 to –2.5 (score 28–30) and in bilinguals from 2.5 to –1.5 (score 25–29). In many cases, Q-SIN score for bilinguals was out of monolinguals' score range and the difference was statistically significant. In case of CV in noise test at for example SNR 0 dB, monolinguals had scores of 11–14 and bilinguals 14–19, which shows a significant difference. This result is in agreement with Krizman et al. in Spanish-English bilinguals with a mean age of 14 and normal hearing. They showed that bilingualism would affect Q-SIN score and reduce the score. This functional difference was attributed to the different language information in the target stimulus for speech understanding in noise. In other words, for bilinguals, Q-SIN has meaningful materials so it provides more language information of the second language or in non-dominant language than non-sense syllables [10].

In another study conducted by Lucks and Mendel, Q-SIN score was lower in Spanish-English bilinguals with normal hearing and competence in the second language than monolinguals. This finding is in agreement with the present results and shows that sentence understanding in noise is affected by bilingualism [9].

Tabri et al. tested speech perception in different SNRs with different materials and showed that bilinguals had lower performance with reducing SNR in speech in noise test with sentence material than monolinguals. In quiet, both groups showed comparable performance [22].

In general, this study attempted to investigate two different central auditory processing via two different tests and the effects of bilingualism were determined. As it was mentioned in the results section, bilinguals showed better CV in noise perception than monolinguals which is attributable to brainstem processing and more brainstem plasticity in bilinguals [21].

Bilinguals showed a lower performance in Q-SIN that according to Dexter and Bidelman, it is attributable to different native and non-native speech in noise processing areas in the brain cortex. They showed that superior temporal gyrus is the responsible area for speech in noise processing in bilinguals but in monolinguals, inferior frontal gyrus does the same processing [23].

Conclusion

Kurdish-Persian bilinguals had better performance in CV in noise (non-sense syllable in noise) but they showed worse performance in Q-SIN (meaningful speech in noise) compared to monolinguals. The difference in results might be due to the difference in extent and way of neural plasticity in different central auditory system levels which calls for further structural and functional investigations in this field.

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Conflict of interest

The authors declare that they have no conflict of interest.

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