

RESEARCH ARTICLE

The effects of bilingualism on auditory memory using Persian version of dichotic auditory-verbal memory test

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Abstract

Background and Aim: Today, Bilingualism is a developing phenomenon which half of the world population is bilingual. Auditory system is the main route to language learning, so it is expected that bilingualism has an effect on functions of the auditory system. Auditory memory is one of the auditory processes which is a cornerstone of linguistic skills and learning process growth, so that, it has an important role in language learning. In this paper, functions of the auditory memory in monolinguals and precocious bilinguals have been investigated through dichotic auditory-verbal memory test.

Methods: A cross sectional-contrastive study of the Persian version of dichotic auditory-verbal memory test has been carried out among 30 monolingual and 30 bilingual persons. The participants were chosen from both sexes in the age range of 18-30, and test scores have been compared in both groups and sexes.

Results: Mean score of dichotic auditory-verbal memory test in monolinguals was 5.47 (from 10), with a standard deviant of 0.55, and in bilinguals were 7.52, with a standard deviant of 0.90, which statistically, it showed a significant

difference in scores between the two groups ($p < 0.001$). There was no significant difference among men and women's scores in monolingual ($p = 0.06$) and bilingual ($p = 0.10$) groups.

Conclusion: Results of this limited research showed that there was a considerable functional difference between monolinguals and bilinguals in dichotic auditory-verbal memory test. Therefore, it seems precocious bilingualism has a positive effect on the auditory memory.

Keywords: Auditory-verbal memory; bilingualism; short term memory

Introduction

Today, Bilingualism and multilingualism are worldwide phenomenon, and there is scarcely a country that a small part of its population is not speaking two languages [1]. A bilingual person uses more than one representation for one linguistic approach, and knows two different languages in two different approaches [2]. It seems that bilinguals have better performances than monolinguals in many cognitive skills, such as problem-solving, creativity, and memory [3]. Researchers also believe since language learning happens through hearing, encountering two languages might have benefits for development of the auditory system [4]. Studies show that auditory cortex of bilinguals is bigger than monolinguals. So it is expected that auditory functions in bilinguals is different

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from monolinguals [5].

Memory and language are closely related in bilinguals. For language learning, correct encoding and retrieval of information from memory is needed, on the other hand, language as a medium is used to encode and store information [6]. As one of the auditory processes, the auditory memory has a role in language learning. Auditory memory is the ability to receive auditory stimuli, process and store them, and remember the heard topics. This kind of memory is the cornerstone of linguistic skills growth (such as learning and remembering words and also the ability to perceive and use grammar, oral and written language) and learning process; as if without it the language has no meaning [7].

In spite of the importance of auditory memory for language learning, limited studies have evaluated the function of the auditory memory between monolinguals and bilinguals. However, different types of memory have been investigated in bilinguals; including working memory, episodic memory, and phonological memory, and due to the superiority of executive functions, research results show the advantage of the bilinguals over monolinguals [8,9,10]. Useful researches have been carried out on the functions of auditory system. Krizman et al. examined the effects of bilingualism on auditory encoding of sounds by using auditory brainstem response (ABR) with auditory stimulus of "da". They predicted, due to the superiority of cognitive skills such as attention, the auditory processing have been affected as well. Results showed that bilinguals have stronger encoding of "da" stimulus than monolinguals, particularly in fundamental frequency (F0) and this result is due to the superiority of executive functions of participants [11]. In the study by Bak et al., they investigated the selective auditory attention and change in auditory attention in monolinguals and bilinguals by using behavioral tests. In this study, bilinguals in both types of auditory attentions had a better performance than monolinguals [12]. In Jalilvand Karimi et al. auditory capacity (maximum ratio of information that could be processed by auditory system) in

monolinguals and bilinguals have also been compared through consonant-vowel dichotic test. In the test, according to the correct recognition percent of the consonant-vowel pairs, the auditory capacity was examined, which is an indication of the ability of the auditory system in storage and remembering oral information. Results of this research showed the auditory capacity is higher in bilinguals in compared with monolinguals [13]. Considering the lack of available studies on examining the effect of bilingualism on the auditory memory, and also the importance of the auditory memory in language learning, the goal of the present study is the comparison of the short-term auditory memory in monolinguals and bilinguals through Persian version of dichotic auditory-verbal memory test. Regarding the increase in bilingual population, similarities and differences between bilinguals and monolinguals plays an effective role in the study of second language effects on the auditory process and they can be used to interpret the results of the auditory central tests.

Methods

Current cross-sectional study was carried out on monolingual (Persian-speaking) and bilinguals students (Persian was their second language) of the School of Rehabilitation Sciences of Iran University of Medical Sciences. 30 participants (15 males, 15 females) out of monolingual students and 30 participants (15 males, 15 females) out of bilingual students were selected through available sampling method. This study was carried out in the Audiology Clinic of School of Rehabilitation Sciences of Iran University of Medical Sciences during two months. Entrance criteria for the study include, normal, symmetric hearing, normal speech discrimination score, normal tympanometry and normal acoustic reflex threshold in both ears, right hand dominance (according to Edinburgh Handedness Inventory), lack of history of ear diseases, head injury, accident, brain surgery, seizure and no substance or ecstasies drug abuse. Participants' age range is 18-30 which in bilingual group they started learning Persian at

the age of 4 to 7. Subjects also passed the Mini-Mental State Examination (MMSE).

At first, Edinburgh handedness inventory test was carried out to prove the right handedness of participants. MMSE test was also carried out to ensure the participants' cognitive situation. To prove acuteness of peripheral hearing, participants were checked up for Otoscopy, immittance audiometry, pure tone audiometry (PTA), and speech audiometry. The normal criteria were immittance audiometry that was carried out through Zodiac 901 (Madsen, Denmark), Tympanogram Type A, and obtaining reflex in 75 to 90 dB SL in frequencies of 500, 1000, 2000 and 4000 Hz in acoustic reflex test. PTA carried out through Orbiter 922 (Madsen, Denmark) in frequencies of 250 to 8000 Hz. Average of pure tone thresholds in frequencies of 500, 1000 and 2000 Hz was considered normal if it was better than 25 dB HL (based on ASHA, 2004). In speech audiometry, all of participants must obtain the discrimination score of more than 90 percent for monosyllabic words in silence mode for both ears. After giving a consciously written permission, qualified subjects entered in the study and tested by dichotic auditory-verbal memory test. Persian version of dichotic auditory-verbal memory test was created by Aghamollaei et al. in 2011 and was carried out on an adult group aged 18-30 years old. According to reported results, Persian version of this test gained 96 percent of content validity index (CVI) [14]. The test was carried out via a computer. The items were delivered via ear-phone at the most comfortable level (MCL). This level was set up with presenting 4 or 5 first words of one of the recorded lists according to the person's report. The test included 6 lists composed of 10 words each. While presenting each word, simultaneously the word was presented to other ear in reverse order. Before beginning the test, participants received this instruction: "simultaneously, you'll hear different words from both ears. You must listen to only right/left ear, and at the end state how many words you can remember. Remembering order of the words and repeating them have no

effect on your score." Words, in order of remembering, were written down by the tester. To increase the validity of results, the test was carried out three times and each time with different lists. There was a 20 second interval between presenting the lists. Examined ear (the ear that received target stimulus) was frequently switched from one list to another. Meanwhile, the test was carried out on the right ear of half of the participants and on the left ear of the other half. Average scores of three presented list to one ear was considered as the ear score, and the average scores of both ears was considered as subject's total score in the dichotic auditory-verbal memory test.

The current study, for observation of Ethics has received approval from research department of Iran University of Medical Sciences.

Data were described as mean \pm SD SPSS 19 was used for statistical analysis and data were interpreted at significant level of $p=0.05$. Kolmogrov-Smirnov test was used to identify the distribution of data normality. All data had normal distribution ($p>0.05$). Thus, statistical independent t-test was used for comparison of the test score of monolingual and bilingual group and also the effect of sex on the test results of each group.

Results

In the current study, among each group, 90 percent of subjects were Bachelor of Science students and 10 percent were Master of Science students. Mean age of monolinguals was 21.20 (SD=1.18) and in bilinguals 20.87 (SD=1.35). Table 1, shows the mean of total score of dichotic auditory-verbal memory test in monolingual and bilingual groups. In each of the two groups, mean total scores were also evaluated according to sex (Table 2). Comparison of the mean total scores of dichotic auditory-verbal memory test in monolinguals and bilinguals was statistically significant ($p<0.001$). Comparison of the test score in monolingual men and women showed no significant difference ($p=0.06$). In the bilingual group, comparison of men's scores and women's ones was not statistically significant as

Table 1. Mean (standard deviation), minimum, and maximum score of dichotic auditory-verbal memory test in monolingual and bilingual groups

Group	Number	Mean (SD)	Minimum	Maximum	p
Monolingual	30	5.47 (0.55)	4.33	6.33	□0.001
Bilingual	30	7.52 (0.90)	6.16	9.33	

well ($p=0.10$).

Discussion

In this study, short term auditory memory function was examined through dichotic auditory-verbal memory test in monolinguals and precocious bilinguals, and results of present samples showed significant increase in the score of dichotic auditory-verbal memory test in bilingual group in compared with monolingual group. Men and women's performance had no significant difference in monolingual and bilingual group. According to the current study, the auditory memory as one of the important functions of auditory system is positively influenced by precocious bilingualism.

No similar studies were found on examining the effect of bilingualism on auditory memory function, so results of the studies on examining the auditory or memory function in monolinguals and bilinguals were used for discussion. The results of studies showed that because of encountering two languages during lifetime, some structural changes occur in different areas of brain [15]. Auditory system, as main route of language learning, is influenced by bilingualism as well. So the auditory cortex in bilinguals is larger than monolinguals [5]. The important difference in the auditory system of bilinguals in compared with monolinguals can be effective on the auditory functions of bilinguals. According to the current study, the auditory memory as one of the important functions of auditory system has been positively influenced by bilingualism. In addition to auditory memory, positive effects of bilingualism on functions of auditory system were observed in auditory encoding of sounds and auditory capacity as well [11,13].

One of the other effective factors in dominance of auditory memory function in bilinguals is having a potent auditory attention [12]. Potent attention causes better encoding of stimulus in memory, and is associated with memory in this way [16]. Goldstein et al. also showed that pre-frontal cortex in bilinguals has more activity than monolinguals [17]. This area has a role in the auditory memory [18].

A lot of researches were carried out in the field of the effects of bilingualism on memory; such as Parsaei et al. on working memory [8], Kaushanskaya and Yoo [9] on phonological memory, and Schroeder et al. on peripheral memory. In all of these studies dominance of bilinguals function over monolinguals' were observed, and because of this difference in performance, it is reported that bilinguals have stronger executive functions [10].

In this study, men and women's performance examined in dichotic auditory-verbal memory test in both groups. In spite of higher scores of women in compared with men in both groups of monolinguals and bilinguals, this difference in scores in both groups was not statistically significant. In a study conducted by Hugdahl et al., which used English version of dichotic auditory-verbal memory test, the effect of sex was not examined statistically; however, in this study, results showed that there was different performance of two sexes in dichotic auditory-verbal memory test, and women had a better performance compared to men [19]. In the current study, this finding was observed in both groups. Aghamollaei et al. showed the effect of sex on Persian version of dichotic auditory-verbal memory test, in which women had better performance than men, and this difference in performance was statistically significant [20].

Table 2. Mean (standard deviation), minimum, and maximum score of dichotic auditory-verbal memory test for men and women in monolingual and bilingual groups

Group	Men				Women				p
	Number	Mean (SD)	Minimum	Maximum	Number	Mean (SD)	Minimum	Maximum	
Monolingual	15	5.29 (0.60)	4.33	6.16	15	5.66 (0.43)	4.83	6.33	0.06
Bilingual	15	7.26 (0.85)	6.16	8.33	15	7.79 (0.91)	6.50	9.33	0.10

One of the reasons that the current study was not corresponding with the study by Aghamollaei et al. from sex aspect, was the entrance criteria in these two studies. In Aghamollaei et al. study, inclusion criteria was being native speakers of Fars in both monolingual and bilingual groups. But in the current study, people are selected more carefully, in which monolinguals only speak Persian and bilinguals speak fluently in their native and Persian Language as well. Maybe due to the different sample method selection in spite of definite dominance of women's performance over men's, in the current study, this difference was not significant. Because of lack of studies on examining the effect of sex on results of Persian and English version of this test, we cannot give a distinct comment on dominant performance of women in compared with men, and this requires carrying out studies with larger samples.

At the end, it is concluded that since language learning usually happens through hearing, bilingualism positively affects the functions of auditory system, including auditory memory. Due to the limited number of examined people, results of this study could not be generalized to individuals of society, and conducting the test on larger samples is needed for generalization. This study provides the context for more discussions and examinations on bilinguals, and uses electrophysiological and central tests in studying the features of auditory system in these people.

Conclusion

In limited samples of the present study, dichotic

auditory-verbal memory test shows that precocious bilinguals have a positive effect on the auditory memory as one of the functions of the auditory system.

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