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The Effect of Bilingualism on the Processing of Clustering and Switching in Verbal Fluency Tasks

Najme Mardani[1]*, MSc; Mohammad Pourjafari[1], BSc; Mohammad Amin Irandegani[1], MSc; Nassim Ahmadi[2], MSc; Kowsar Baghban[3], PhD

[1]Department of Speech Therapy, Faculty of Rehabilitation Sciences, Zahedan University of Medical sciences, Zahedan, Iran
[2]Department of Speech Therapy, Faculty of Rehabilitation Sciences, Iran University of Medical sciences, Tehran, Iran
[3]Department of Speech Therapy, Faculty of Rehabilitation Sciences, Hamedan University of Medical sciences, Hamedan, Iran

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ABSTRACT

Background: This study examined the effect of bilingualism on the processing of clustering and switching in verbal fluency tasks in Farsi-Balochi bilinguals. Because of our little information about bilingualism effect on verbal fluency performance, and given the importance of this skill, the aim of the present research is to explore the verbal fluency performance of Farsi-Balochi bilinguals.
Methods: This was a cross-sectional, descriptive-analytical study. Ninety participants entered this study, including 45 Farsi monolinguals and 45 Farsi-Balochi bilinguals. All participants were male university students between the ages of 18 to 24 years. Verbal fluency tests were performed and the clustering and switching scores were calculated. Data were analyzed in SPSS-16 software.
Results: The monolingual group obtained a score of 32.84 in the total semantic fluency task and 24.13 in the phonemic fluency task, while the bilingual group obtained 30.70 in the semantic task and 29.37 in the phonemic task. The number of switches between the clusters and the mean cluster size were 35.82 and 2.6 in the monolingual group and 38.65 and 2.26 in the bilingual group, respectively. The difference between groups in phonemic fluency, phonemic switching, and semantic clustering was significant ($P<0.05$).
Conclusion: The bilingual group performed better in phonemic fluency and switched more between the clusters. Meanwhile, the monolinguals produced more words in each cluster than the bilinguals.

Introduction

Verbal fluency performance is a word retrieval ability that is dependent on language [1] and executive processing [2]. Verbal fluency performance depends on cognitive flexibility, inhibition skills, vocabulary span, and vocabulary search strategies [3, 4]. This performance is evaluated using the verbal fluency test, which consists of two subtests (semantic fluency and phonemic fluency). In this test, the participant is required to express words from a particular semantic or phonemic class within a given time, usually one minute [5]. Semantic fluency performance is strongly correlated with language ability [6], while phonemic fluency is significantly correlated with executive functioning [3]. Based on psycholinguistic models, words are retrieved primarily on the basis of semantic representation [7]. The semantic fluency task has this advantage that the respondents are required to produce words on the basis of semantic relationships [3]. In the phonemic fluency task, however, words are retrieved on the basis of phonologic relationships, which is not a common strategy. Studies in this field have shown that the phonemic fluency task requires executive control demands [3].

Troyer et al. [8] proposed a method for scoring the verbal fluency test based on the clustering of words

*Corresponding author: Najme Mardani, Doctor Hesabi Sq., Zahedan University of Medical Sciences, Faculty of Rehabilitation Sciences, Zahedan, Iran. **Tel:** +98 9377877702;
Email: Najmemardani@gmail.com

and switching between the clusters. They suggested that words are produced in semantic or phonemic subcategories, and when the production of words from one subcategory is completed, the subject switches to another subcategory [8]. Switching is a cognitive task, while phonemic clustering is a language-related task and semantic clustering is a verbal semantic-memory task [9].

Verbal fluency performance is influenced by several factors, including gender [10], age [11, 12], education [4], culture [13], language, and bilingualism [14]. Some studies have suggested that semantic fluency performance is influenced by both age [15] and education [4], while phonemic fluency performance is influenced by education [4] and bilingualism [15]. Furthermore, some studies have shown that clustering performance and switching performance are influenced by gender, as women make more switches than men, while men use large cluster sizes [10, 16]. Semantic fluency performance has been shown to deteriorate with age; meanwhile, semantic and phonemic verbal fluency tasks improve with education [4]. Furthermore, some studies have shown that semantic fluency performance is lower in bilingual adults, while phonemic fluency performance is not different between bilingual and monolingual adults [4, 17, 18]. One study also reported higher phonemic fluency performance in bilinguals, while there were no differences in semantic fluency performance between bilinguals and monolinguals [19]. Another study showed that there are differences between bilingual and monolingual adults in both semantic and phonemic fluency, as bilingual adult speakers had a lower performance compared to monolinguals [20]. As for children, semantic fluency was shown to be lower in bilingual children, while phonemic fluency was better in them compared to monolingual children [3, 17]. The poorer performance of bilingual children in semantic fluency performance appears to be due to the lower vocabulary in bilingual compared to monolingual children [3]. The researchers' review of literature did not show any studies on the subject of switching and clustering strategies in bilingualism.

Despite the practicality and importance of the verbal fluency test, there has been little research and much ambiguous information on the verbal fluency performance of bilingual speakers. Therefore, this study sought to investigate the effect of bilingualism on the verbal fluency performance of Persian-Balochi adults. Because bilinguals have less vocabulary than monolinguals [21] as well as a lower word retrieval ability [22], one cannot predict how they will perform on the phonemic fluency task. Given the lack of studies on this subject in Persian-Balochi bilinguals, the present study may be a good starting point for further research in this area.

Methods

Design

This cross-sectional, descriptive-analytical study was conducted on two groups matched in terms of age, education, and gender using pair matching. All participants filled out the consent form before entering the study.

Participants

Ninety participants entered this study and were assigned to two groups: monolingual (n=45) and bilingual (n=45). The inclusion criteria for both groups were: being a male university student aged 18-24 years with a Mini-Mental State Exam (MMSE) test score ≥24 and being right-handed. The inclusion criteria for the monolingual group consisted of having Farsi as their own and their parents' native (first) language. For the bilingual group, the inclusion criteria consisted of self-reported bilingualism (score ≥4 in all four domains of the Fisherman and Cooper [24] scale in both Farsi and Balochi languages), being born and raised in a Farsi-Balochi region (Sistan and Baluchistan Province), and having Farsi-Balochi as their parents' native language. The exclusion criteria for both groups were having a history of alcohol consumption, drug addiction, head injury, stroke, epilepsy or other neurological diseases, or taking antidepressant medications.

Measures

The MMSE [23] was administered to evaluate each participant's cognitive status. A five-point self-rating scale (the Fisherman and Cooper scale) [24] was also used to evaluate the degree of bilingualism [24].

The verbal fluency test [5] that has two subtests (phonemic fluency and semantic fluency) was performed. In the phonemic fluency subtest, the participants were requested to name words that begin with a particular letter (such as "Sh", "A", or "S") over one minute. For the semantic fluency subtest, the participants were requested to name words from a specific category (such as animals or fruits). The examiner recorded their responses. For scoring test results, participants' responses were categorized in clusters based on the standard manual of the test [5]. For this purpose, the total number of words for each subtest was counted. Then, for the semantic fluency section, words within each category (animals/fruits) were categorized in terms of their categorization method (birds, aquatics …/ citrus, dried fruits …). The categories and subcategories of each section are explained in the verbal fluency test manual [5]. This procedure was repeated for the phonemic fluency section in that words were categorized for each letter (Sh, A, S) in terms of their phonological features within a proper cluster. The number of switches is equal to the number of clusters minus one, and the cluster size is equal to the number of words within each cluster minus one; finally, the mean cluster size is equal to the total cluster size divided by the number of clusters.

Data Analysis

Statistical analyses of the data were performed in SPSS (version 16.0. Chicago, SPSS, Inc.). The Shapiro-Wilk test was used to examine the distribution of the data. The independent t-test was performed for normally-distributed data and Mann-Whitney's U-test for the non-normally-distributed data.

Results

Participant Characteristics

The 45 monolingual and 45 bilingual participants of

Table 1: Verbal fluency test results

	Monolingual group	Bilingual group	P value
Total naming			
Verbal fluency	56.73 (Mean)	59.84 (Mean)	0.067
Semantic fluency	32.84 (Mean)	30.70 (Mean)	0.661
Phonemic fluency	24.13(Mean)	29.37 (Mean)	0.002*
Mean cluster size			
Semantic clustering	1.7 (Mean)	1.50 (Mean)	0.005*
Phonemic clustering	0.85 (Mean)	0.76 (Mean)	0.649
Total clustering	2.6 (Mean)	2.26 (Mean)	0.027*
Switching			
Semantic switching	15.24 (Mean)	16.58 (Mean)	0.09
Phonemic switching	17.20 (Mean)	22.14 (Mean)	0.001*
Total	35.82 (Mean)	38.65 (Mean)	0.005*

the study were matched in terms of age, gender, and education using paired matching. The participants had a mean age of 21 years (range: 18 to 24 years), a mean number of years of formal education equal to 15, and a mean MMSE score of 28. All the Farsi-Balochi speakers rated themselves as proficient in both languages (scores greater than 4 in all domains of both languages).

Data Analysis Results

Table 1 presents the details of the participants' verbal fluency performance. There was no difference between groups in total semantic fluency (P>0.05). But, in total phonemic fluency, the bilingual group obtained significantly higher scores than the monolingual group (P<0.05).

The monolingual group generated significantly more words in each cluster and, therefore, obtained higher scores in terms of the mean cluster size (P<0.05). In each subtest, the monolingual group placed significantly more words into the semantic clusters (P<0.05), but the difference between the two groups was not significant in terms of phonemic clustering processing (P>0.05).

The monolingual group generated significantly more words in each cluster and, therefore, obtained higher scores in terms of the mean cluster size (P<0.05). In each subtest, there was no difference between groups in switching between semantic clusters (P>0.05); however, the bilingual group obtained significantly higher scores in phonemic switching (P<0.05).

Discussion

In the present study, bilingual participants generated more words than monolingual participants in the phonemic fluency task. This finding concurs with the results obtained by Bialystok et al. [19] regarding the better phonemic fluency performance of bilinguals, but is inconsistent with the results reported by Pereira et al. [4], Portocarrero et al. [17], and Rosselli et al. [18], which showed no differences in phonemic fluency performance between bilinguals and monolinguals. This result is also inconsistent with the results reported by Gollan et al. [20], which showed that bilinguals perform poorer in phonemic fluency tasks than monolinguals.

The present study also showed that there are no significant differences in semantic fluency between bilinguals and monolinguals. This finding is consistent with the results obtained by Bialystok et al. [25], which indicated the lack of differences between bilinguals and monolinguals in semantic fluency. Meanwhile, it is inconsistent with the results obtained by Pereira et al. [4], Portocarrero et al. [17], and Roselli et al. [18], which showed a poorer semantic fluency performance in bilinguals. This finding is additionally inconsistent with the results reported by Gollan et al. [20], which showed the poorer performance of bilinguals than monolinguals in semantic fluency tasks. Semantic fluency performance is related to language abilities [6]. According to Fernandes et al. [21], bilinguals have less vocabulary than monolinguals [23]. Gollan et al. [22] also demonstrated that bilingual speakers have slower word retrieval than monolingual speakers; as a result, this study expected bilinguals to produce fewer words in the semantic fluency tasks than monolinguals. Nevertheless, the findings revealed that Farsi-Balochi bilinguals performed equally to monolinguals in semantic fluency tasks. According to this result, bilingualism seems to have no disadvantage in terms of language abilities in bilingual Farsi-Balochi speakers. The language abilities of bilingual Farsi-Balochi speakers and monolinguals need to be further explored and compared.

In the present research, the monolingual participants produced more words in the semantic clusters than the bilingual participants. Since semantic clustering is a verbal semantic memory task related to the left temporal lobe function [9], bilingualism seems to cause a disadvantage in verbal semantic-memory performance. The present findings also showed no differences between the two groups in terms of phonemic clustering. Since phonemic clustering is a language-related task associated with the temporal lobe function [9], bilingualism appears to produce no disadvantage in language abilities for bilingual Farsi-Balochi speakers.

The present findings showed that semantic fluency and phonemic clustering are similar in bilinguals and monolinguals. Troyer et al. [9] noted that these two processes are related to language abilities and the temporal lobe function. Therefore, it seems that bilingualism produces no disadvantage or advantage in terms of language skills and temporal lobe functioning in Farsi-Balochi speakers.

In the present study, the bilingual group obtained higher scores in phonemic and total switching, but there was no difference between the groups in terms of the semantic switching scores. According to Troyer et al. [9], switching is a cognitive shifting ability (an executive

function) related to the frontal lobe function. It thus seems that bilingualism has a positive effect on executive functioning (and maybe frontal lobe activation) in Farsi-Balochi speakers. This finding is attributed to the good performance of this bilingual group in phonemic fluency tasks, which are related to executive functioning. Meanwhile, the semantic switching scores were not significantly different between the two groups, which may be due to the small sample size.

Among the limitations of the present study were the non-participation of individuals in the sampling process due to its time consuming, and also the elimination of some individuals due to lack of inclusion criteria or having exclusion criteria, which made the sampling process longer.

Finally, to clarify the advantages and disadvantages of bilingualism in terms of language abilities and executive functioning, further studies need to be conducted with larger sample sizes on the correlation between executive functioning, language abilities, verbal fluency performance, and brain function in Farsi-Balochi bilinguals. Comparative studies on the verbal fluency performance of Farsi-Balochi bilinguals and other bilinguals are also required in order to determine whether or not it is the particular features of the Balochi language that affect cognitive and linguistic skills this way.

Conclusion

It seems that bilingualism has no advantage or disadvantage on language skills and temporal lobe performance in Farsi-Balochi speakers, but this has a positive effect on executive functioning and frontal lobe performance in Farsi Balochi bilinguals.

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Conflict of Interests: None declared.

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