Original Article

Comparison of Phonemic Fluency Test Results Using Different Letters among Persian Speakers

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ABSTRACT

Background: The purpose of this study was to compare the results obtained from phonemic fluency test using "F"[1], "A"[2], "S"[3] and "L"[4], "T"[5],"M"[6] among Persian Speakers aged between 20 and 30 years.

Methods: In this applied study, 76 subjects were randomly chosen. The data was analyzed separately for each subject according to the three letters: "F", "A", and "S" by using the routine phonemic fluency subtest of verbal fluency test and then phonemic fluency performance was gathered by using the three letters: "L", "T" and "M" and after scoring according to Troyer method, the resultant numbers were reported after statistical analyses. For statistical analysis using SPSS 19, the distribution of data was firstly evaluated. Due to the fact that the data distribution was normal, Bonferroni test was used to compare the scores of the letters.

Results: No significant gender and educational level effects were found and therefore, all further analyses were conducted without taking gender and educational level into account. Also, when the results of the three letters: "F", "A" and "S" as a group for phonemic fluency performance and "L", "T" and "M" letters as a different group, were integrated, a significant difference was found between the mean cluster size and switching between these two groups, while there was no significant difference between the average cluster size and cluster number.

Conclusion: Based on the findings of this research, it can be concluded that the results of phonemic fluency test in each of the six letters are significantly different. Therefore, when using the special letters in the Persian language, it is necessary to examine all the letters for phonological sub-tests and use the simplest letters to study this function.

1 F: the 23rd letter of the Persian alphabet pronounced /**fe**/
2 A: the first letter of the Persian alphabet pronounced /***aː***/
3 S: the 15th letter of the Persian alphabet pronounced/**sɪn**/
4 L: the 27th letter of the Persian alphabet pronounced/**'laːm**/
5 T: the 4th letter of the Persian alphabet pronounced/**'te**/
6 M: the 28th letter of the Persian alphabet pronounced/**'mɪm**/

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Introduction

Verbal fluency test is a short and concise test that is used to examine defect in the ability to articulate words

[1] of conscious mental processing and generally, the ability to communicate verbally [2], and analyze the ability to produce language content [3].

This test is an appropriate tool for examining language disorders with different causes [4] the tasks related to this test (semantic fluency and phonemic fluency) for semantic and cognitive psychological assessment. Search in the lexicon and the recovery of the treasury of vocabulary and memory is widely used [5, 6].

With the use of the assignments related to this test, useful information on the growth of word recovery strategies and semantic-lexical networks can be obtained [7]. It seems that such assignments are appropriate tools for identifying the verbal deficiencies and also examining the function of special parts of the brain [5]. In verbal fluency performance, there is activation in the left frontal lobe and left medial temporal lobe [2].

The performance of verbal fluency is evaluated in two ways, that is, semantic and phonemic fluency. Phonemic fluency assignments are kinds of activities in which the subjects are asked to articulate words beginning with a certain letter in a certain time [3].

In fact, the phonemic fluency shows the ease of producing words by the individual. Such tests do not only examine the ability to articulate words but also study conscious mental processing. For instance, when naming, one should be able to quickly search among his mental words and find the proper word from the communicative regions of the brain (left frontal and temporal lobes), and then express the word. He must repeat this as long as it has been set [7].

There are several methods to study phonemic fluency. Some researchers have examined the timing of the word-taking and based on that, they evaluated the performance of the word finding of the subjects. This method only indicates whether people with communicative disorders have some difficulty to find the words or not but the main root of such difficulty cannot exactly be traced [8].

Troyer has suggested a method to study the quality of phonemic fluency in which the number of transitions and the mean cluster size are analyzed. Troyer reported that cluster size indicating subjects' ability to access the words in semantic or verbal subsets and the transition, could be used to measure subjects' ability to transfer effectively from a subset to another. In other words, clustering is used to evaluate the individuals' lexicon, while the transition is the ability to switch between clusters in a phonological domain and evaluate the processes that are performed for the purpose of the search [9, 10].

This test is a benefit neuropsychological test for examination of verbal deficiencies (linguistic processing of words recovery) and executive function [11]. Neurological disorders such as Parkinson, Huntington, frontal and temporal lobe lesions [12], multiple sclerosis [13] as well as Amyotrophic Lateral Sclerosis (ALS) [8] can affect verbal fluency.

In fact, phonemic fluency test is used to analyze conscious mental processing. For example, the individuals must quickly shift through their mental lexicon to find proper words from brain connective areas and prefrontal cortex and then utter the word. They must repeat this process during the allotted time. It is necessary to mention that verbal skills of subjects affect the results of the test [13].

Typically, different letters are used in such tests for examination of the subjects' performance. For this test, the most common letters are "F", "A" and "S" and the reliability and validity of the mentioned letters have already been analyzed in Persian [14]. Valuable results can be obtained through verbal fluency test, for instance, the probability of a neurological disorder in a person or the eventual development of a neurological disorder that the person faces [15]. This performance is influenced by some factors including, culture, gender, education, age and most importantly, language [10, 16].

The performance of phonemic fluency test in various languages was through different letters and most of them reached the conclusion that the letters "F", "A", "S" are the best options for examination of this performance and more importantly, the performance of phonemic fluency depends on language [15]. This study aimed to compare the performance of intact individuals in this function using the letters "F" "A" "S" and "M", "T", "L" to " to find out whether "F", "A", "S" are the simplest letters in Persian for studying phonemic fluency or not. The letters "M", "T" and "L" were randomly selected from the Persian alphabet. Furthermore, there are few researches done on the best letters for phonemic fluency test. Therefore, the present study examined this matter. The results of this research will help in the more effective use of the test in the clinical setting.

Methods

Participants

The purpose of this study was to compare the results of phonemic fluency test using "F"[1], "A"[2], "S"[3] and "L"[4], "T"[5], "M"[6]; among 20 to 30 years old Persian Speakers. For this purpose, 76 normal subjects aged 20 to 30 were chosen using the standard deviation of research in this field in the Portuguese language [17] to assess the sample size through the following formula:

$$n = \frac{(1.96 + 0.84)^2(4.05^2 + 4.05^2)}{(13.67 - 11.84)^2} = 76$$

The inclusion criteria were: healthy participants, participant's age ranging from 20-30 years (this age range was selected due to reliability and validity of test for this age range) and first and predominant language being Persian. Exclusion criteria were: a history of head injury in the last 10 years, stroke, long-term use of alcohol or drug addiction, epilepsy or other neurological disease, taking antidepressant medication and hearing loss.

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6 M: the 28th letter of the Persian alphabet pronounced/'mɪm/

Design

Phonemic fluency test: Consistent with Troyer [10] instruction, the participants were asked to produce as many words as possible beginning with "F", "A" and "S", within 1 min for each letter. They were not allowed to use proper nouns, such as people's, city and country names or same words with different suffixes. The following instructions were given: "I give you a letter, then you try to produce quickly, as many words as you can, which are initiated with that letter, within one minute. Please be careful not to produce proper nouns or same words with different suffixes. For instance, if I say "M" you can say magazine, machine, etc., but you should not say Mashhad, Maryam, Malaysia (proper nouns), or same words with different ending". Then, if participants understood this instruction, they were asked to do main test letters ("F", "A" and "S"). Then, the same procedure was for letters "L", "T" and "M".

Statistical Analysis

Finally, scores of the subjects were calculated after sampling. In this method of scoring, the total number of words produced by each participant for each letter was calculated. Also, clustering of words and the number of switches between clusters were calculated. Finally, mean cluster sizes, total number of words and number of switching were compared among different letters that are used for this study ("F", "A", "S", "L", "T" and "M"). Then, statistical analyses were done using SPSS19. For this purpose, the distribution of data was firstly evaluated. Due to the fact that the data distribution was normal, Bonferroni test was used to compare the scores of the letters.

Results

In this study, 76 subjects were chosen from Mashhad Faculty of Medical Sciences (46 male and 30 female students). The minimum and maximum ages were 21 and 30, respectively and the average age was 24.59±2.14.

The subjects were 35 BA students (46.1%), 10 post graduate students (13.2%), 26 PhD students (34.2%) and 5 specialized PhD students (6.6%). The results of phonemic fluency test are shown in Table 1. The variance analysis of repeated measures (ANOVA) indicated that the results of phonemic fluency test in the six letters were significantly different ($P<0.05$). The mentioned numbers in the last column (the first two numbers) are the results obtained from Croit Test Processing.

The results obtained from Bonferroni Test (ANOVA) are shown in Table 2. The mentioned numbers not in parentheses are absolute values of difference averages and the numbers in parentheses are related to the P value.

Table 1: Examination of the Normality of Data using Kolmogorov-Smirnov Test

Variable	Number	Average	Medium	Standard Deviation	Minimum	Maximum	F Statistics (P value)
Total Number of "F"	77.00	8.21	8	2.57	2	13	W-0.751
Total Number of "A"	77.00	9.26	9	3.08	2	17	(0.104)
Total Number of "S"	77.00	10.58	10	3.5	5	19	
Total Number of "M"	77.00	10.86	11	3.8	2	19	27.528
Total Number of "T"	76.00	10.54	10	3.44	3	20	(≥0.001*)
Total Number of "L"	77.00	7.49	7	3.11	2	19	
Mean cluster size of "F"	77	2.01	2	1.53	0	7	W-0.002
Mean cluster Size of "A"	77	1.47	1	1.34	0	7	(≥0.001*)
Mean cluster Size of "S"	77	2.75	2	1.79	0	8	
Mean cluster size of "M"	77	3.17	3	2.09	0	8	11.131
Mean cluster Size of "T"	77	4.31	3	8.26	0	72	(≥0.001*)
Mean cluster Size of "L"	77	1.81	2	1.52	0	6	
Cluster numbers of "F"	64	7.34	7	2.8	2	17	W-0.522
Cluster numbers of "A"	61	8.46	8	2.92	1	15	(0.090)
Cluster numbers of "S'	72	8.86	9	3.49	2	18	
Cluster numbers of "M"	71	8.65	8	3.53	2	18	7.035
Cluster numbers of "T"	69	8.22	8	3.17	2	21	(≥0.001*)
Cluster numbers of "L"	61	6.26	6	2.82	1	15	
Error Number in "F"	77	1.22	1	1.35	0	8	W-0.468
Error Number in "A"	77	0.7	0	0.97	0	4	(≥0.001*)
Error Number in "S"	77	1.13	1	1.22	0	6	
Error Number in "M"	77	1.14	1	1.55	0	8	11.192
Error Number in "T"	77	0.45	0	0.72	0	4	(≥0.001*)
Error Number in "L"	77	1.14	1	1.25	0	5	
Number of switches "F"	77	6.43	6	2.91	1	16	W-0.733
Number of switches "A"	77	7.51	7	2.8	2	14	(0.060)
Number of switches "S"	77	7.95	8	3.49	1	17	
Number of switches "M"	77	7.88	7	3.37	1	17	15.616
Number of switches "T"	77	7.21	7	3.11	1	20	(≥0.001*)
Number of switches "L"	77	5.12	4	2.88	0	14	

Significant at the level of 5%

Table 2: Summary of comparison between different letters (results of Bonferroni Test)

Variable		f	a	s	m	t	l
Total Number	f	-	1.053 (0.063)	2.408 (≥0.001*)	2.711 (≥0.001*)	2.316 (≥0.001*)	0.697 (0.979)
	a		-	1.355 (0.014*)	1.658 (0.001*)	1.263 (0.049*)	1.750 (≥0.001*)
	s			-	0.303 (≤0.999)	0.092 (≤0.999)	3.105 (≥0.001*)
	m				-	0.395 (≤0.999)	3.408 (≥0.001*)
	t					-	3.013 (≥0.001*)
	l						-
Mean cluster size	f	-	0.545 (0.076)	0.740 (0.035*)	1.156 (0.001*)	2.299 (0.309)	0.208(≤0.999)
	a		-	1.286 (≥0.001*)	1.701 (≥0.001*)	2.844 (0.064)	0.338 (≤0.999)
	s			-	0.416 (≤0.999)	1.558 (≤0.999)	0.948 (0.001*)
	m				-	1.143 (≤0.999)	1.364 (≥0.001*)
	t					-	2.506 (0.180)
	l						-
Clustering	f	-	0.861 (≤ 0.999)	1.631 (0.180)	1.833 (0.017*)	0.694 (≤ 0.999)	1.194 (0.432)
	a		-	0.500 (≤ 0.999)	0..972 (≤ 0.999)	0.167 (≤ 0.999)	2.056 (0.028*)
	s			-	0.472 (≤ 0.999)	0.667 (≤ 0.999)	2.556 (0.001*)
	m				-	1.139 (0.573)	3.028 (≥0.001*)
	t					-	1.889 (0.007*)
	l						-
Switching Number	f	-	1.078 (0.148)	1.519 (0.001*)	1.455 (0.003*)	0.779 (0.963)	1.312 (0.013*)
	a		-	0.442 (≤ 0.999)	0.377 (≤ 0.999)	0.299 (≤ 0.999)	2.390 (≥0.001*)
	s			-	0.650 (≤ 0.999)	0.740 (≤ 0.999)	2.831 (≥0.001*)
	m				-	0.675 (0.876)	2.766 (≥0.001*)
	t					-	2.091 (≥0.001*)
	l						-

*Significant at 5% level

Discussion

In this study, the results of phonemic fluency test in the six letters are significantly different (P<0.05).

The data obtained from the research confirmed the initial hypothesis of our research that the degree of difficulty in naming words is based on their initial letters. This finding is in line with research conducted on English-speaking individuals as well as Portuguese-speaking individuals [17].

The findings obtained from research carried out in other languages indicated that the letters "F", "A" and "S" were the simplest letters to articulate words in one minute, while the present study which was done in Persian indicated that the three letters were not considered the simplest letters in words articulation but the letters "L", "T" and "M" were the major letters used and articulated by the subjects in the best classification. In other words, the mentioned letters were the simplest options to articulate words as compared to other words examined through the test.

The results obtained from examining Persian subjects performance using "F", "A" and "S" are not comparable to those obtained from examination of English subjects who participated in similar phonemic fluency test. The remarkable point in this study is that even in the case of the person's performance in the easiest letters (in the production of words starting with "S, M, and T") in Persian, the total number of words is lower than that of the Portuguese speakers in the simplest letters [17].

The subjects examined in this test included BA, MA and PhD students. The results indicated that the levels of education among the subjects are not significantly different with regards to their performance. This finding contradicts that of research conducted on education as a factor in the performance of a person in the fluency test of speech [12]. This is probably due to the fact that, the subjects used in this study were selected from only three academic levels in the university (BA, MA and PhD). Therefore, the diversity of the level of education in the sample was low and the number of subjects at each level was less than necessary. So, it seems that extensive research is needed in this regard to a great extent.

Also, with regards to the age of the subjects studied, the findings of the research were contrary that of research on the impact of age on phonological fluency function and it was noted that with the age of up to fifty, phonological fluency function increases [18]. In this study, the findings indicated that age had no effect on verbal fluency performance. It seems that the case study was done over a limited age range (20 to 25 and 25 to 30). And with a closer look at this, it is better to research on a larger age range with more samples.

The results indicated that the subjects' performance in articulating the total number of words, cluster average size and transmission number in the three letters "S", "M" and "T" had no significant difference. In other words, difficulty level of their performance in the mentioned letters was the same. On the other hand, there was statistically significant difference among the other letters uttered by the subjects to articulate at least in three cases including the total number, cluster average size and transition number. These findings indicate that the three letters "S, M, T" are the same in terms of the level

of difficulty in the six letters. Therefore, other Persian letters can be studied in this regard in order to obtain a more comprehensive result on the level of difficulty of phonological fluency function with different letters in Persian language. As shown in the findings of the study, the letters "L" and "F" are letters that indicate the minimum performance of individuals. It seems that this is due to low frequency of words which started with these letters in the Persian language [7]. In this regard, a study indicating the frequency of words starting with different letters of Persian language was not performed; thus, it can open a new window for further research. In addition, the number of clusters, the average clusters size, and number of transitions in the letters "F" and "L" are lesser than that of the letters "S, M, T". This finding shows that the subjects performed the classification of the letters "F" and "L", with more difficulty. In other words, classification of the words starting with these letters seems to be in the lexicon of individuals relative to "S, M and T" following less phonological relations.

By examining the data from the research, it is clear that the classification of words in the lexicon of individuals follows a phonological relationship, but the degree of phonological interference in the classification of vocabulary in lexicon is different for different letters. Different factors seem to affect this issue, but factors and how they affect this categorization are ambiguous. Given this, it seems that further research is needed to clarify this issue.

The results obtained from the words articulated by the subjects indicated that despite the fact that semantic relationships were effective in words recovery, such relationships had no effect on the subject's mental lexicon. It seems that semantic relationships are involved in the search term only if the search term's limitations are based on the initial words (similar to those of the phonological test) [5].

Due to the fact that the considered letters have different features phonemically [7], the researchers may assume that words articulation beginning with the simplest phonemic features has the highest frequency but by examining the phonetic characteristics of each of the letters studied, it was found that these characteristics were very different even for letters that were considered to be the same with regards to difficulty in naming. Therefore, these phonetic features do not seem to affect the performance of the subject in any of the test letters.

The limited sample size, examination of only three letters from the Persian language, and limited age range were among the limitations of this study. It will be beneficial if broader studies are conducted to examine all letters of Persian language in this test and identify the linguistic features of letters that affect phonemic fluency test output in Persian speakers and present the best letters to examine this function.

Conclusion

Based on the findings, performance of participants in phonemic fluency test is affected by letters selected for test. It means that performance of any participant can be different when the letter selected for test is changed, and it can be better if letters are selected on the basis of their linguistic features, frequency or other factors that can interfere with one's performance examined. The best letters for phonemic fluency test among Persian speakers have to be selected based on linguistic (Farsi language) features of letters.

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