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The Effect of Syllable Structure on the Frequency of Disfluencies in Adults With Stuttering

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Background: Stuttering is one of the most prevalent speech and language disorders. Symptomatology of stuttering has been surveyed from biological, developmental, environmental, emotional, learning and linguistic viewpoints. Literature shows that syllable structure as a linguistic feature, may influence the frequency of disfluencies.
Objectives: This study aimed to determine the effect of syllable structure on the frequency of disfluencies in adults with stuttering.
Patients and Methods: This cross-sectional descriptive-analytic study was performed on 16 adults (14 males and 2 females) who stutter with the mean age of 24.56 years. The frequency of disfluencies was evaluated by asking the subjects to read two lists, one list contained 60 words and another one consisted of 60 nonwords. The words and nonwords were selected based on simple and difficult syllable structures. The data were statistically analyzed through paired t-test using the SPSS software.
Results: The results of this study showed a significant difference between the frequency of disfluencies between the simple syllable structures and difficult syllable structures in nonword reading tasks ($P < 0.05$). There was no significant difference in the frequency of disfluencies between the simple syllable structures and difficult syllable structures in word reading tasks ($P > 0.05$).
Conclusions: The findings of this study indicate that the frequency of disfluencies was increased in difficult syllable structures in comparison to simple syllable structures. According to the results, it seems that certain linguistic features, such as syllable structure can affect speech-motor output in people who stutter through affecting phonological encoding.

Keywords: Stuttering; Adult; Disfluencies Frequency; Word; Non- word; Syllable Structure

1. Background

Stuttering is one of the most prevalent and complex fluency disorders of speech, which is known by interruptions in the natural process of speech. The most common symptoms of stuttering are sudden and abnormal pauses due to the repetitions, prolongations and blocks of speech sounds (1, 2). This disorder has a multidimensional and complicated nature that affects approximately 1% of the adult population (3). Despite, the wide researches which have studied stuttering from different aspects, the nature of this disorder has remained unknown and for this reason it has been the focus of investigators for many years (4).

Recent researches have indicated the relationship among the linguistic factors such as syntactic construct, syntactic complication, the position and type of word, the length of word, syllable structure and the informative load of the word with the stuttering (5-8). Syllable structure of the word has a specific importance among the other linguistic factors, regarding the presence or absence of consonant cluster, because syllable structure is one of the most effective factors in phonological encoding, which can have an influence on the frequency of disfluency occurrences among people with stuttering. If a defect or delay is happened in the phonological encoding level of the speech production process, it would be possible that a speech production system runs an incomplete phonological program. Therefore, an incorrect motor program of phonological and motor sequence will run or the speed of processing is decreased in phonological and motor sequence retrieval, that both lead to the stuttering (9, 10).

This issue has argued in the Covert Repair Hypothesis (CRH) that argues stuttering is a by- product of self-corrections. These corrections are responses to the incidence of errors and defects in the phase of phonological planning in the speech processing, that speakers do these covert efforts to correct those errors. Based on this hypothesis, the major problem that creates stuttering exists in linguistic system or more precise in phonological system of the people who stutter (11). Postma and Kolk argued that the existence of the slow speed of processing in phonological system in the people who stutter creates stuttering in response to the large quantity of errors and the covert self-corrections (12, 13). They believed that in

the phonological process cycle, processing of target phoneme from the competent phonemes takes a long time (during the production of a word) and this increases the probability of occurrence of defect in selection of the correct phoneme. This defect will be followed by the speech monitoring system activity, which is responsible for inspection and review of encoded speech before speech production (covert repair) and during speech production (overt repair). Whenever this system identifies any kind of phonological errors before incidence or afterward, an interruption will be occurred and when speech restarts, different signs of stuttering will be appeared (12, 13).

Based on the CRH, it seems that testing people who stutter using two-word lists, which include words and nonwords with simple syllable structures (without consonant cluster) and difficult syllable structures (with consonant cluster), can provide proper information about the influence of syllable structure as a linguistic factor on speech-motor output in these people. Differences in the frequency of speech disfluencies, with regard to the existence or nonexistence of a consonant cluster in the syllable structure of words, had made researchers to conduct some studies in this area.

In a study, Smith et al. investigated the effect of phonological complexity on the speech disfluencies in people who stutter. For this purpose, they used a task of repetition of one to four- syllable nonwords, which gradually were increasing their phonological complexity. The results showed that by increasing the phonological length and complexity, the disfluency moments in people who stutter will enhance (14). Ludlow et al. considered the frequency of speech disfluencies by reading a task, which is consisted of complicated nonwords with the length of four syllables. The results showed that disfluency moments in adults with stuttering are more than people without stuttering. Furthermore, it was declared that defect in phonological encoding can influence speech production in people who stutter, and increase disfluencies in their speech (15). Riecker et al. investigated the relation between phonological complexity and frequency of speech disfluencies in adult with stuttering. Their results showed the frequency of disfluencies in nonwords with consonant cluster is more than nonwords lacking the consonant cluster (16). Ononiwu et al. compared the frequency of speech disfluencies in adults who stutter in languages with simple syllable structure (without consonant cluster) and the languages with difficult syllable structure (with consonant cluster). The results showed the frequency of stuttering in languages with consonant cluster is more than languages without consonant cluster (17). Howell et al. by studying the influences of phonological complexity on the frequency of speech disfluencies in people who stutter, concluded that the presence of a consonant cluster in the word syllable structure, causes a significant increase in the frequency of speech disfluencies (18).

Despite the fact that indicates linguistic factors such as syllable structure have an important effect on the frequency of speech disfluencies in the adult with stuttering, no research has been conducted on this topic and in this age-range in Iran up to now. Regarding the structural difference of Persian with other languages and lacking a proper study in this area, the necessity of conducting such a study is obvious.

2. Objectives

This study aimed to examine the effect of syllable structure on the frequency of speech disfluencies in adults with stuttering. Moreover, the main objective of this study was to compare the frequency of disfluencies in the words and nonwords with the simple syllable structure (without consonant cluster) and difficult syllable structure (with consonant cluster) in adults with stuttering.

3. Patients and Methods

3.1. Subjects

This study is a cross-sectional descriptive-analytic study. The sample size in this study was calculated based on the need to have sufficient statistical power and according to the standard deviation reported by Smith et al. Sixteen stuttering adults (mean age = 24.56 years, SD = 5.26, range = 20-39, 14 males and 2 females) participated in this study. Participants were selected from clients attended to speech and language clinic of Iran University of Medical Sciences. The inclusion criteria for participants in this study were: their age had to be above 20 years, diagnosed as individuals with developmental stuttering after doing some evaluation by a speech-language pathologist, they had to have no other neurological and/or communication disorders except stuttering, no history of stuttering and/or speech therapy sessions at least 3 to 6 months prior to the study. Persian was the first language of all participants and every participant had-at least- high school education. Exclusion criteria included unwillingness to continue the evaluation and video and audio recording.

3.2. Test Materials

In this study, two lists, one was consisted of 60 words and another was consisted of 60 nonwords with simple (without consonant cluster) and difficult (with consonant cluster) syllable structures were used. List of words and nonwords were designed as follows:

1. In the beginning, simple and difficult syllable structures for 1 - 5 syllable words were extracted from "Auditory Test of Phonological Awareness Skills" book (19). As there is not a wide variety of one-syllable structures in Persian language, only 2 types of syllable structure were selected for the one-syllable group. For other groups, 4 kinds of syllable structures (2 simple syllable structures and 2 difficult syllable structures) were chosen.

- In one-syllable group, only using of one simple syllable structure and one difficult syllable structure was possible.

- To match the number of words in the one-syllable group to other groups in word list and nonword list, 6 words were selected for every group; therefore, there were 12 words in each syllable groups in final lists.

2. The most appropriate simple syllable structures and the most appropriate difficult syllable structures for 1 - 5 syllable words were chosen by a linguist.

3. For each structure, 9 words were selected. These amounts were 3 times more than that was considered for goals of the study.

- All the words were selected from the content word category.

4. Then a list which contained 180 words was sent to 8 professional speech and language pathologist and linguist and they were asked to select 60 suitable words based on frequency of their usage. They should tick one of the following choices: "it is necessary, it is helpful but not necessary, it is not necessary" and in the end, content validity and the index of content validity were calculated using the Lawasche method (Table 1).

5. In the next step, the list of nonwords was designed from the word list with respect to 2 criteria; a. complete similarity in consonant, and b. vowel variation. Length and syllable structure of nonwords were similar to words. Examples: "words with simple syllable structures: kælaq, pæzirayi", "words with difficult syllable structures: qædrdani, pærtgah", "nonwords with simple syllable structures: kulaq, pazarayi" and "nonwords with difficult syllable structures: qodrduna, partgæh".

6. Finally, the lists of words and nonwords, twice and at an interval of one week were conducted on 14 adults with stuttering and the reliability of test was calculated with test-retest (ICC and SEM) and the internal consistency (Tables 2 and 3).

Table 1. The Content Validity Index of a List of Words

Syllable Groups	CVI
One syllable	0.83
Two syllable	0.87
Three syllable	0.85
Four syllable	0.81
Five syllable	0.83
Total	0.83

Table 2. The Result of the Test Reliability Consideration Using the Repeatability Method [a]

Lists	Correlation Coefficient	ICC	SEM
Words	0.85	0.919	1.06
Non-words	0.90	0.948	1.19
Total	0.91	0.956	1.46

[a] Abbreviations: ICC, intraclass correlation coefficient; SEM, standard error of measurement.

Table 3. Reliability Consideration Using Internal Consistency

Lists	α
Words	0.71
Non-words	0.93

3.3. Procedure

Initially, the subjects completed the consent form and demographic questionnaire. At first and in order to confirm the diagnosis of stuttering, Stuttering Severity Instrument-3 (SSI-3) was used. Participants were asked to read a 200-word text and an examiner has a short conversation with each examinee. Then participants were given two lists containing 60 words and 60 nonwords to determine the effect of syllable structures on the frequency of disfluencies in the reading task. Participants were instructed to read the words and nonwords loudly, without using any therapeutic techniques that may be self-taught or learned during the previous therapies. If participants faced to moment of stuttering during the reading they were asked not to control it. They were also asked to read each list individually and only once. Auditory and visual symptoms had been recorded by a video camera (SAMSUNG model VP- DX 10) and voice recorder (Kingston model DVD 902). In the next step, two speech and language pathologists without a former acquaintance with the participants of the study investigated and evaluated the films and sound samples, 3 times separately, with more than 2 day intervals, individually and unaware of each other. Each of syllables that was expressed with one kind of stuttering signs, the repetition, prolongation and block, was recognized and considered as a syllable with stuttering.

3.4. Statistical Analysis

Normality of measurement data distribution was tested using the Kolmogorov-Smirnov one-sample test. When the distribution of the measurements was normal, data were analyzed using SPSS 16.0. Paired t-test was used and odds ratio was calculated, and the significance level was set at $P < 0.05$.

3.5. Ethical Considerations

The purpose of this study was explained to participants, and then we asked them to sign a consent form before taking a test. They were assured that their information would remain confidential and the tests were completely safe and noninvasive.

4. Results

In the recent study, 16 adults with stuttering (14 men and 2 women) with the mean age of 24.56 and standard deviation of 5.26 were participated. The youngest and the oldest examinees were 20 and 39, respectively and all of them had at least high school education. The results of comparison between the mean and standard deviation of the frequency of disfluencies in the simple and difficult syllable structures existed in the lists of words and nonwords have been shown in the Tables 4 and 5. For this purpose, first the mean of frequency of speech disfluencies in the simple and difficult structures of each of the words

Table 4. The Mean and Standard Deviation of the Frequency of Disfluencies in the List of Words in Adults With Stuttering [a, b]

Variables	Mean ± SD	Difference in Means	df	t Value	P Value
Simple syllable structure	3.38 ± 3.181	0.625	15	1.619	0.126
Difficult syllable structure	4.00 ± 3.246				

[a] Data are presented as Mean ± SD.
[b] The means by distinct letter stressing faintly different at 0.05.

Table 5. Mean and Standard Deviation of Frequency of Disfluencies in the List of Nonwords in Adults With Stuttering [a, b]

Variables	Mean ± SD	Difference in Means	df	t Value	P Value
Simple syllable structure	13.81 ± 6.025	8.188	15	6.572	0.000
Difficult syllable structure	22.00 ± 6.000				

[a] Data are presented as Mean ± SD.
[b] The means by distinct letter stressing faintly different at 0.05.

and nonwords lists was calculated, and then regarding to the normality of distribution of the data, paired t-test was used. There was no significant difference in the mean frequency of disfluencies between simple syllable structure and difficult syllable structure in the words list (P = 0.126); however, there was a significant difference in the mean frequency of disfluencies between simple syllable structure and difficult syllable structure in the nonwords list (P = 0.000).

5. Discussion

In the present study, the effect of syllable structures on the frequency of disfluencies in adults with stuttering was examined. For this purpose, the words and nonwords with simple syllable structure (without consonant cluster) and difficult syllable structure (with consonant cluster) were used.

The results of this study showed that the mean of frequency of disfluencies in the difficult syllable structure was more than that of the simple syllable structure in list of words; however, the difference was not statistically significant (P = 0.126); this finding did not match Howell et al. study. The results of their study showed that the presence of the consonant cluster in the syllable structure of words has a significant influence on the frequency of disfluencies among the people with stuttering (18). Two probable reasons could explain this difference between the result of ours and Howell et al. study; size of speech sample and the overuse of words with a high frequency.

In the list of nonwords, difference in the mean frequency of disfluencies between simple syllable structure and difficult syllable structure was statically significant. These findings are consistent with the results of Smith et al. study, by comparing the frequency of disfluencies in one to four syllable nonwords which gradually increased their complexity, they concluded that with increasing in phonological complexity, the frequency of disfluencies in speech of people with stuttering increases (14).

Similarly, Ludlow et al. by investigating the frequency of disfluencies in a reading task of complicated nonwords found that, enhancement in phonological complexity is one of the effective factors on the frequency of disfluencies in the adult with stuttering (15). In a similar study, Riecker et al. investigated the influence of phonological complexity on the frequency of disfluencies among the adults with stuttering and concluded that the frequency of disfluencies in the nonwords with consonant cluster is more than nonwords without consonant cluster (16). The results of this study are consistent with the results of Ludlow et al. (15) and Riecker et al. (16) studies. Also, Ononiwu et al. obtained similar results of the survey of stuttering frequency in languages with and without consonant cluster (17). The results of such researches confirm the findings of the recent study.

It seems that a significant difference in the mean frequency of disfluencies among the simple and difficult syllable structures in the nonwords list can be justified according to Riecker et al. study. They expressed that the existence of consonant cluster in the word syllable structures causes the enhancement of activities in the brain zones that are effective in the planning and execution of motor speech. They also declared that the motor characteristic in production of the words with consonant cluster is very complicated (16, 20). It seems that existence of a consonant cluster in the syllable structures is one of the most effective factors that cause some difficulties in motor planning. Therefore, phonological encoding- that is part of motor planning process (21) is much harder in difficult syllable structures with two or even more consonant cluster than simple syllable structures. Since people who stutter have some defects in their phonological systems (22, 23) and their severity of stuttering usually increased in facing with difficult syllable structures. Therefore, we can conclude that the existence of two or more consonant clusters in difficult syllable structures increased load of linguistic processing for the phonological system. According to CRH, in these conditions, possibility of error occurrence which is followed by error covert repair increases in the target plan. Such an influence is observable in the recent investigation, in the form of

high frequency of disfluencies in nonwords with difficult syllable structure, rather than words with simple syllable structure. Therefore, we can conclude that the finding of this section of the research supports the CRH.

Generally, the results of the recent research showed that the frequency of disfluencies in difficult syllable structures is more than simple syllable structures. Existence of consonant cluster in the syllable structures is an effective factor that increases phonological encoding complexity, especially in nonwords. Thus, we can conclude that existence of consonant cluster in the syllable structure of word can influence on the speech-motor stability and control in people who stutter, with affecting on the performance of phonological system. Hence, regarding the results of the recent research, it seems to be useful for speech and language pathologists to concentrate on the effect of the linguistic factors particularly syllable structures in clinical evaluations and a design of the therapy. It should be mentioned the lack of controlling the effect of word frequency as a limitation of the current study. In Persian, the word frequency control due to the lack of a specific source for words with high frequency and words with low frequency in adult is very difficult or even impossible, because many factors such as level of the education, culture, the amount and type of study will affect it. Therefore, the effect of this factor must be considered in interpreting the result of the study.

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Authors' Contributions

Elham Masumi: data collection, drafting, writing and submitting the manuscript. Zohre Arani Kashani: drafting. Nafise Hassanpour: editing the manuscript. Mohammad Kamali: data analysis.

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