

Research Article



Development of Persian Monosyllabic and Disyllabic Words for Auditory Test of Adults and Evaluation of Their Face Validity Using Psychometric Function

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Citation: Hassani H, Ahadi M, Jarollahi F, Jalaie S. Development of Persian Monosyllabic and Disyllabic Words for Auditory Test of Adults and Evaluation of Their Face Validity Using Psychometric Function. *Aud Vestib Res.* 2024;33(3):202-7.

doi <https://doi.org/10.18502/avr.v33i3.15501>

Highlights

- In this study, 382 monosyllabic and 150 disyllabic words in Persian were prepared
- Psychometric function parameters were used for assessing the prepared words

Article info:

Received: 10 Sep 2023

Revised: 21 Oct 2023

Accepted: 04 Nov 2023

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ABSTRACT

Background and Aim: The utilization of speech materials in audiological assessments has faced challenges due to a lack of standardization and insufficient consideration of acoustic factors. This study aimed to develop a set of psychometrically validated monosyllabic and disyllabic words in Persian for use in auditory tests.

Methods: This cross-sectional study involved collecting the most frequently used one- and two-syllable words from Persian dictionaries. A panel of experts evaluated the selected words using a 4-point Likert scale. Based on their recommendations, 382 monosyllabic words and 150 disyllabic words met the established criteria. Male and female talkers recorded these words, which were then presented in a random order to 30 young adults with normal hearing (aged 18–30 years). The presentation intensity levels ranged from 0 to 48 dB HL with 8 dB increments. Logistic regression was used to determine the psychometric properties of the words.

Results: As the intensity level increased, the percentage of word recognition scores also increased, reaching 100% at an intensity level of 48 dB HL. For Persian monosyllabic words, the mean psychometric slope was 0.29 %/dB for male talkers and 0.25 %/dB for female talkers. The corresponding slopes for Persian disyllabic words were 0.23 %/dB and 0.21 %/dB, respectively.

Conclusion: This study successfully developed 382 monosyllabic words and 150 disyllabic words in Persian with comparable psychometric properties. These words can be utilized in auditory tests for Iranian adults.

Keywords: Monosyllabic words; disyllabic words; psychometric function; logistic regression; Persian speech materials



Introduction

Speech is an auditory stimulus through which we communicate [1]. Hearing problems has negative effects on the communicational function of people [2]. Age-related changes not only affect the cellular structures of the cochlea but also affect the central nervous system, especially the auditory cortex and the frontal lobe. The latter plays an important role in speech recognition, especially when the central auditory areas show a structural integrity disorder [3]. Speech tests are an essential tool for the assessment of hearing and communication impairment. These tests, along with pure tone audiometry, can help determine the type and degree of hearing loss. Speech tests provide a good picture of a person's speech recognition ability at the threshold level and the speech discrimination ability at a level above the threshold level [4, 5]. Speech discrimination is not necessarily related to the degree of pure-tone hearing loss, because some patients have extremely poor speech discrimination despite having a normal pure tone audiogram. Although pure tone audiometry has always been used in hearing evaluations of children and adults, this test has limitations in assessing hearing function [6]. There are several types of test materials to evaluate speech recognition ability, including meaningless sentences, words, and syllables; however, there are limitations in the use of unusual words and long lists that increase the test time, and in recording the test materials, which reduces the reliability and validity of the existing test materials. Due to the increasing clinical need to overcome the inefficiency of existing test lists, it is necessary to create a list of monosyllabic and disyllabic words [7, 8].

Although many studies in Iran have been conducted in recent years to create Persian word lists [9-11], the obtained lists were in accordance with the objectives of their own study; limited study has been conducted to create a treasure of Persian words (monosyllabic and disyllabic) for the audiology tests. For instance, in 2021, Mahdavi and Rabie reported psychometric function characteristics of the CVC monosyllabic Persian words and constructed three full-lists based on psychometrical equivalency entitled SBMU-1 words [12]. According to Nissen et al. [13], the talker's accent and frequency spectrum can affect the speech recognition score. Moreover, psychometric indicators have been given less

attention in making the Persian word lists. A psychometric function describes the relationship between a person's performance in psychophysical tasks and some features of the physical stimulus [14]. Psychometric function for speech recognition describes a person's ability to recognize speech as a function of its intensity. The psychometric function has two parameters: Threshold (the level of intensity required to achieve a 50% correct performance level) and slope (the rate of change in correct performance with changes in the intensity level). The slope of the function is very important because it determines the increase in speech recognition caused by small changes in intensity. This means that the steep slope of the psychometric function shows that a small increase in the intensity level can lead to a significant increase in speech recognition. Conversely, if the slope is relatively shallow, the same small change in the intensity level cannot lead to an increase in speech recognition. As a result, the speech recognition psychometric function is often S-shaped [14]. This study aims to create a set of monosyllabic and disyllabic words using the parameters of the psychometric function for a battery of audiology tests, including central auditory processing disorder tests.

Methods

Various Persian dictionaries [15, 16] were first used to collect monosyllabic and disyllabic words. As a result, 777 monosyllabic words and 3914 disyllabic words were selected based on factors such as their frequency and familiarity in everyday conversations, cultural and linguistic suitability, and adherence to the syllabification of monosyllabic words (CVCC, CVC, CV). The words such as proper nouns, vocative letters, conjunctions, prepositions and adverbs, and those which were semantically and culturally unusual were excluded.

After explaining the study objectives and the questions, 14 audiologists were asked to classify each of the selected words based on a 4-point Likert scale. Based on their opinions, 407 monosyllabic words and 644 disyllabic words were selected. After applying the specified criteria, 382 monosyllabic words and 150 disyllabic words were found to meet the requirements. The selected words were meticulously recorded in a specialized studio by two male and female talkers with a standard Persian accent, as recommended by Nissen et al. [13]. The recordings were done with three repetitions

per word, ensuring that no errors were made by the talkers. Each audio was saved as a 24-bit WAV file at a sampling rate of 1.44 kHz. The intensity level of the recorded words was adjusted using the Praat program to match the root mean square of all words as 1000-Hz calibration tone.

Participants were 30 individuals with normal hearing (15 males) aged 18–30 years ($\text{mean}=24.75\pm 3.46$ years). The reason for using normal-hearing subjects was to find out how well each monosyllabic or disyllabic word can be recognized at different intensity levels. To facilitate the presentation, scoring and control of the sessions, the monosyllabic and disyllabic words were randomly divided into nine 50-word lists and thirteen 50-word lists. All the lists were played by male and female talkers for each person and presented through headphone and binaurally in an acoustic room. Before presenting the words, the participants were informed that they would listen to Persian words at various intensity levels. They were asked to listen carefully and repeat the words out loud. If some words were challenging for them to hear, they could guess the words. They were advised to wait for the next word, if they preferred not to guess. The words were presented in a random order, from 0 dB to 48 dB HL, with increments of 8 dB. A short break was given after playing each list. Monosyllabic words were presented in one session and disyllabic words were

presented in another session, and each session lasted approximately 4 hours.

Previous studies have used various statistical methods to establish the psychometric function [17-19]. In this study, according to the studies by Mahdavi et al. [12] and Nissen et al. [13], we used logistic regression, which represents a nonlinear relationship between the intensity level of the stimulus as a continuous variable and a binary variable (correct or incorrect recognition of words) [14].

Results

The psychometric function of monosyllabic and disyllabic words (recorded by male and female talkers) using the regression model is depicted in Figure 1. For monosyllabic words, as the intensity level increased, the percentage of correct word recognition increased and reached the highest value at high intensity levels (100% correct recognition at an intensity level of 48 dB HL). For the words recorded by male talker, the mean regression slope was 0.29 %/dB (ranged from 0.07 to 0.74 %/dB). For the words recorded by female talker, the mean regression slope was 0.25 %/dB (ranged from 0.06 to 0.69 %/dB).

For disyllabic words, as the intensity level increased,

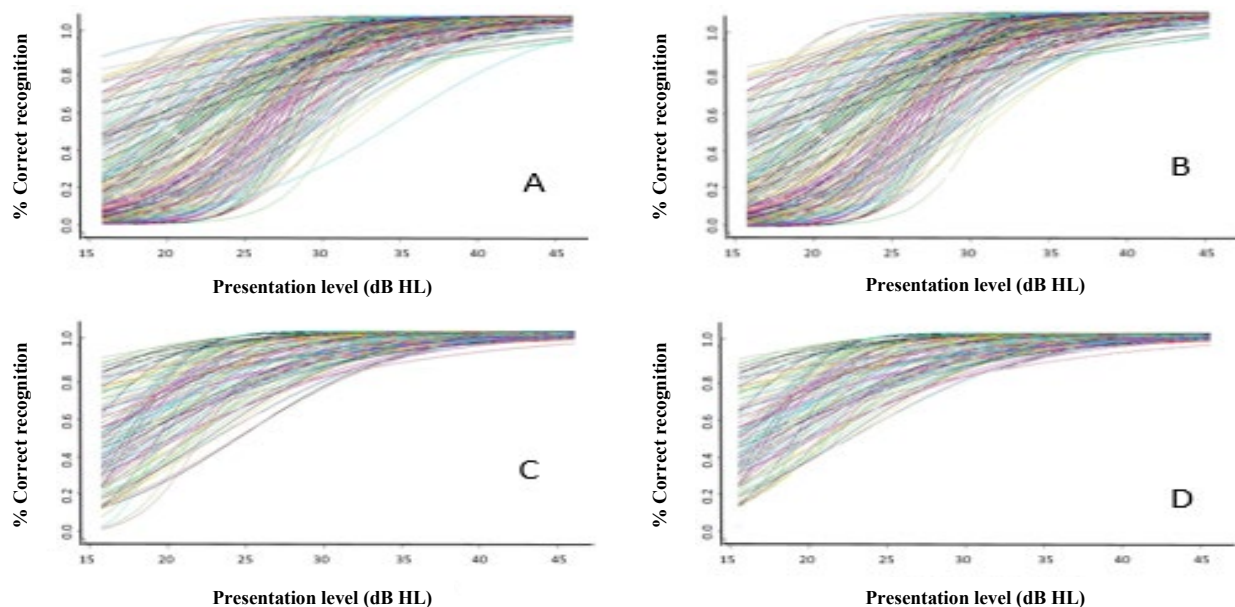


Figure 1. The psychometric functions which show the recognition percentage of monosyllabic words at different intensity levels for male (A) and female (B) talker and also the recognition percentage of disyllabic words at different intensity levels for male (C) and female (D) talkers

Table 1. The psychometric function characteristics of the mono/disyllabic Persian words reported for this study

Word	50% dB HL threshold	Slope 50% dB	Slope 20–80% dB
Monosyllabic(male talker)	23.28	20.42	19.47
Monosyllabic (female talker)	24.18	19.24	18.31
Disyllabic (male talker)	15.77	25.97	25.21
Disyllabic (female talker)	16.57	24.79	24.13

the percentage of correct word recognition increased and reached the highest value at high intensity levels (100% correct recognition at an intensity level of 48 dB HL). For the words recorded by male talker, the mean regression slope was 0.23 %/dB (ranged from 0.07 to 0.73 %/dB). For the words recorded by female talker, the mean regression slope was 0.21 %/dB (ranged from 0.06 to 0.71 %/dB).

The mean recognition score of monosyllabic and disyllabic words was not significantly different between males and females ($p>0.05$) and they were equally able to correctly recognize the words. The characteristics of the psychometric function for monosyllabic and disyllabic words are reported in [Table 1](#).

Discussion

The purpose of this study was to develop a set of monosyllabic and disyllabic words in Persian with psychometric properties, which can be used in a battery of audiological tests. These tests are essential for obtaining accurate results and designing effective auditory treatment or rehabilitation programs. The results yielded a set of 382 monosyllabic words and 150 disyllabic words all with comparable psychometric properties. This set of words can be utilized by audiologists in Iran based on their requirements.

Unlike previous studies [9, 20, 21], the focus of this study was not on achieving phonetic balance in the word lists. Mosleh et al. [9] created and evaluated lists of 25 phonologically balanced monosyllabic words for Persian-speaking adults and showed no significant difference in the scores obtained from the 12 lists based on gender. On the other hand, the list of foreign words (W-22 and CNC), which focused on phonological balance could not represent the real phonological

balance of everyday conversations. With the phonetic balance of a word list, the familiarity of a word has a more pronounced effect on the recognition accuracy [20]. Martin et al. [21] suggested that, although phonetic balance is important, it is not the sole or primary factor for determining the uniformity of the word list.

In psychometric functions, the slope of the word list at 50% recognition in Persian language is steeper than in other languages [12]. The mean slope (50%) of the psychometric function in this study (20.42 %/dB for monosyllabic words with male talker and 19.24 %/dB for for monosyllabic words with female talker) is similar to the study by Mahdavi et al. [12] who examined the psychometric properties of Persian monosyllabic words on 30 people with normal hearing aged 18–25 years (mean slope at 50%=7.6 %/dB). The differences between Persian and other languages can be due to the phonetic, syntactic and semantic structure of the speech materials. Richard et al. [22] conducted a study for constructing, evaluating and psychometrically matching of a list of Korean monosyllabic words to measure word recognition. Their results showed no significant difference in terms of audibility between the lists and half-lists between males and females, which is consistent with the results of the present study. In Hirsh et al.'s study [23], the slope of the psychometric function for words indicated the homogeneity of the speech materials. They suggested that one reason for the greater slope of function for disyllabic words compared to monosyllabic words can be the greater homogeneity of spondic words. As reported in our study, the mean slope of the psychometric function for disyllabic words was higher than that for monosyllabic words. Wilson and Carter [24] investigated speech recognition performance of 12 people with normal hearing for 100 W-22 words and 100 PB-50 words in silence and at intensity levels of 0–56 dB HL in 8 dB steps. The functions for W-22

words (less variability) were more homogeneous than for the PB-50 words. The mean slope of functions for W-22 words (1.3 dB) was higher than that for PB-50 words (1.9% dB).

Psychometric properties can vary even in a single language. For instance, in Mahdavi et al.'s study [12], the threshold and psychometric slope for monosyllabic CVC words ranged from 13.5–10.7 dB HL and 6.2–4.1%/dB, respectively. In contrast, this study showed that the threshold for 50% of monosyllabic words ranged from 1.30–36.23, with skewness values between 0.07–0.74. The differences in psychometric properties among different studies can be attributed to several factors. These factors include the gender of the talker, the considered incremental steps, the method of calibration for spoken materials, the statistical model used for the analysis, and the syllable formation selected for the research. These variables can contribute to differences in the results obtained in the studies [12, 21, 24].

Conclusion

In this study, 382 monosyllabic words and 150 disyllabic words in Persian with similar psychometric properties were prepared which can be used in a battery of auditory tests for Iranian adults.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethical Committee of Iran University of Medical Sciences, Tehran, Iran, Code No: IR.IUMS.REC.1398.986.

Funding

This study was the M.Sc. project supported by Iran University of Medical Sciences (Code: 1400-1-6-21070).

Authors' contributions

HH: Conceptualization, data collection, recording speech materials; MA: Conceptualization and design of the study, supervision, project administration, and editing; FJ: Conceptualization and design of the study, and editing; SJ: Statistical analysis.

Conflict of interest

The authors declare no competing financial interests or personal relationships that could have influenced the work reported in this paper.

Acknowledgments

We would like to convey our appreciation to all the individuals who took part in the study.

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