Research Paper: Developing and Examining the Psychometrics of Single-word Quick Repetition Test for Speech Sound Production in Persian-speaking Children

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ABSTRACT

Objectives: The present study aimed to develop and validate a quick repetition test using familiar and culture-based words for assessing Persian-speaking children with Speech Sound Disorders (SSDs).

Methods: The study sample was divided into two groups, including 419 participants without any clinical signs of speech impairment and 36 cases with SSD. The psychometric properties of the single word quick repetition test, including reliability (inter-rater and test-retest reliability) and validity (construct, discriminant, convergent, clinical and concurrent validity) were examined. Moreover, the descriptive data for children without SSD were reported.

Results: The obtained test-retest and inter-rater reliability data were satisfactory with Intraclass correlation coefficient (ICC): >0.7. There was a positive correlation between the results of the quick repetition test and phonetic test, indicating the scale's acceptable convergence validity. Using inflated beta-binomial regression, statistically significant improvement in test score was found with age (discriminant validity). Comparing the correct responses of the control and case groups (clinical validity) revealed a significant difference in responses between the study groups. Results of Bland–Altman plot suggested an acceptable agreement between quick repetition test and phonetic test (construct validity).

Discussion: The Persian quick repetition test is a valid and reliable instrument facilitating the screening of speech sound abilities in 3-8-year-olds. Moreover, this test's conciseness makes it easily applicable in clinical practice and epidemiologic investigations. Establishing descriptive data from a large sample facilitated comparing children's speech ability to the speech development standards.

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Highlights

- The obtained data explained the speech characteristics of children with Speech Sound Disorder (SSD).

- We addressed why applying the quick repetition test is necessary for clinical settings.

- We discussed the important psychometric properties of the quick repetition test which made it an appropriate tool for SSD screening purposes.

Plain Language Summary

Speech Sound Disorder (SSD) is dealt with any problem or composition of problems with the perception, motor production, or phonological representation of speech sounds, either in the sound itself or in speech segments. This condition is among the most common forms of communication disorders in children. SSD is highly prevalent among preschool children. Despite the demand for the evaluation and treatment of SSD, no specific screening tool using repetition words is developed in Iran. The high prevalence of this disorder in Iran and its association with reading disabilities during the school years (9-11) highlight the necessity of developing screening tests. In case children fail to successfully pass the routine developmental screening tests, they are referred to a speech-language pathologist for further comprehensive evaluations. The present study findings indicated that the presented Persian quick repetition test was a reliable and valid instrument facilitating the assessment of speech sound abilities in Persian-speaking 3-8-year-olds. Moreover, the conciseness of this test makes it easily applicable in clinical practice and epidemiologic investigations.

1. Introduction

Speech Sound Disorder (SSD) comprises any problem or composition of problems with the perception, motor production, or phonological representation of speech sounds, either in the sound itself or in speech segments [1]. This condition is among the most common communication disorders in children. SSD is highly prevalent among preschool children; this disorder has a prevalence rate of almost 16% among 3-year-old children [2]. This rate has been reported as 13.1% among the children in the first year of primary school in Yazd City, Iran [3].

Fluharty [4] has underscored the necessity of performing highly reliable and valid articulation tests; such inventories are suggested to be culturally and phonemically feasible, simple, comprehensive, and quick to administer and can represent the articulation competence in the pediatric population. Picture naming tests are clinically applied for speech assessment during childhood across the world in different languages Arabic [5], English [6], European-Portuguese [7], Italian [8], and Farsi [9-11]. Such tests target the assessment of the production of all consonant phonemes (23 consonants) in all word positions, namely initial, middle, and final. Implementing the picture naming tests requires the elicitation of long-list words (e.g. 80 words [9] or 180 words [8]).

These tests are time-consuming and caseload management is a significant burden for numerous speech-language pathologists serving children with SSDs [12]; thus, developing a tool facilitating a concurrent assessment within a shorter time with a favorable diagnostic power could be very beneficial. In this direction, Schindler's repetition test has been developed for Italian children [13]. Besides, Tresoldi et al. determined its reliability and validity [14].

Despite the demand for the evaluation and treatment of SSDs, no specific quick tool has been developed for Persian-speaking children. The high prevalence of this disorder and its association with reading disabilities during the school years [15-17] highlights the necessity of developing quick tests to apply on large populations aged 3-8 years. Accordingly, developing a reliable and valid instrument facilitating a rapid repetition could be beneficial in the pediatric field. Such tools could help to screen children in need of referral to a complete assessment of speech and language pathology.

The present study aimed to develop and validate a quick repetition test using familiar, culture-based, and visually transparent words for assessing Persian-speaking children with SSDs. We also provided the descriptive data related to sound development per age group.

2. Methods

The current study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences (Code: IR.MUMS.REC.1398.071). The current study was conducted on 455 Persian-speaking 3-8-year-old children. The study population was divided into two groups of children, including 419 participants without any clinical signs of speech impairment (231 males and 188 females, aged 3;0-8;11 years) and 36 cases with SSDs.

The children of the first group were randomly selected from the kindergartens and schools categorized into 6 age groups with a one-year interval (Table 1). The exclusion criteria for the control group were hearing loss, cerebral palsy, cleft lip and palate, autism spectrum disorders, intellectual disability, and developmental disabilities with social, emotional/behavioral deficits. These criteria were controlled by the child's medical history and reports from teachers and parents. Additionally, each child was subjected to a clinical speech and language assessment by a Speech-Language Pathologist (SLP) to exclude the children with SSDs. Unfortunately, due to limited access to younger children, the number of children in lower age groups was less than that of the older children; this issue is mentioned in the limitations section.

The case group entailed 36 children, including 28 males and 8 females, within the age range of 3-8 years (Table 2). These children were selected from the patients referring to the centers delivering speech and language services in 3 months. The patients with normal hearing (according to their audiogram) and SSD diagnosis according to the phonetic test [9] were included in this group. Children who presented errors of <4 consonants, distortion error type, as well as apraxia and dysarthria were excluded from the study.

After developing the single-word quick repetition test, its validity and reliability were examined. To develop a reliable and valid test, the items were selected from the existing resources by a comprehensive review [18, 19]. It was also ensured that all the items were familiar and culturally-appropriate to 3-8-year-olds.

The quick repetition test consists of 30 one-syllable words with CVC syllable shape (Appendix A), including all Persian phonemes, except the only glottal stop consonant (22 consonants) in the word-initial and word-final positions. Besides, vowels are not assessed in this screening test. The maximum total score for the test is 44 target phonemes (i.e. 22 + 22). This work was generated based on Schindler's repetition test, i.e. developed for

the Italian children. This test consists of a 30-word list, which includes Italian phonemes (21 consonants). Most of these phonemes are present in the initial and medial positions of words. In the Italian language, final consonants are very rare; therefore, they are not part of this articulation test. The task requests child to repeat the uttered target words by the examiner.

The descriptive data were obtained by calculating correct production for a target phoneme in terms of percentage and percentile ranks for the subjects' total score per group. For each consonant, the accuracy percentage was calculated to determine the mastery age (≥90% of children in an age group produce the sound correctly), acquisition age (≥75%), customary production age (≥50%), and the age of approximate production (<50%) [14, 20].

To estimate the inter-rater reliability of our test, 10 children in the control group were simultaneously and independently examined by two speech-language pathologists (a PhD and an MSc in Speech Therapy). Furthermore, the test-retest reliability was investigated by administering the repetition test to 16 children in the case group twice with a 2-week interval.

Content validity is described by the extent to which the content of a test addresses the conceptual domain that it was intended to cover [21]. In the present study, evaluating the content validity of the devised test was investigated by 5 speech and language pathologists who were experienced in working with children with SSDs. Accordingly, the proposed test was thoroughly reviewed by the given therapists to reach a consensus on the suitability of the tested consonant position in the word; the suitability of the age group for ensuring the quality of the material applied in the test; and the familiarity and cultural suitability of the selected words for the children per selected test item.

The responses of the control group participants were subjected to psychometric analysis. The construct validity of the designed test was examined by evaluating its ability to discriminate between different age groups. Moreover, to determine the convergent validity as another subtype of the construct validity, our quick repetition test, along with a more comprehensive articulation test, namely phonetic information test [9], involving a picture-naming test of 80 words that included all Persian consonants in different positions within the word, were administered to 100 healthy children within the age range of 3;0-8;11. Subsequently, the correlation between the results obtained from the two aforementioned tests was calculated. Furthermore, the extent to which a test

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can facilitate the detection or prediction of a disorder is referred to as its clinical validity [22]. The clinical validity of the quick repetition test was investigated by comparing the data of the case and control groups. However, to make these two groups more comparable regarding gender and age, we fitted a multiple logistic regression model and entered age and gender as independent variables (to adjust them) besides the correct responses.

The concurrent validity of our test was determined by assessing the speech abilities of all controls through the proposed quick repetition test and phonetic information test [9]. The children were selected from rehabilitation clinics (group 2), kindergartens, and schools (group 1) in Mashhad City, Iran. They were examined by a speech-language pathologist with 5 years of experience and expertise regarding articulation testing and phonetic transcription.

The articulation skills were individually assessed in each child. Accordingly, the children were requested to repeat each target word after producing it by the examiner. As the words were elicited by imitation, no cues and additional trials were provided.

Thereafter, the examiner scored each word as 1 or 0 in case the target phoneme was uttered correctly or omitted/distorted/substituted, respectively based on an auditory-perceptual evaluation. Accordingly, the minimum and maximum scores in this test are 0 (all target phonemes are omitted/distorted) and 44 (all target phonemes are correctly produced), respectively. The administration of this test takes approximately two minutes per subject.

The obtained data were analyzed in SPSS and R software. The collected data were expressed as frequency, mean, and standard deviation. To achieve descriptive data, for each target phoneme, the correct production percentages, as well as percentile ranks, were calculated for the total scores of each age group.

Data analysis was performed using the Cronbach's alpha coefficient (for internal consistency), Intraclass Correlation Coefficient (ICC; for test-retest and inter-rater reliability); inflated beta-binomial regression (for discriminant validity -the subtype of construct validity-); Pearson's correlation coefficient (for convergent validity- the subtype of construct validity-); a multiple logistic regression analysis between pathological and healthy speaking children (clinical validity), and Bland-Altman plot for concurrent validity.

3. Results

Tables 1 and 2 present the mean and standard deviation scores of the quick repetition test scores in 6 age groups. The test proposed in this study was developed to assess children's ability to accurately repeat all phonemes in the initial and final positions of the target words. Figure 1 presents the data obtained from the test in children with healthy speech development. The age group-wise percentile ranks of the test's total scores are presented in Table 3.

Based on the evidence, Persian-speaking children are mastered in producing nasals, frontal plosives, and /x/ consonant at the age of 3;0-3;11 years. However, the three consonants of /z/, /ʒ/, and /dʒ/ are already mastered by children aged 6;0-6;11 years. Besides, /s/ is the last consonant that children have mastered at the age of 7;0-7;11 years.

The internal consistency of the quick repetition test was confirmed, rendering a Cronbach's alpha coefficient of 0.75; thus, all test items measure a single variable. Moreover, investigating the test-retest reliability among 16 subjects with a 2-week interval reflected a significant correlation between the study subjects' performance at two different times (ICC=74.0, 95%CI=0.3-0.9, P≤0.05). Therefore, the test was concluded to have relatively satisfactory repeatability. Furthermore, exploring the scale's inter-rater reliability revealed that the scores of the two different examiners were close in the 10 subjects and demonstrated a significant correlation (ICC=99.99%, 95%CI=0.99-1.00, P≤0.05).

A method for determining tests' validity is to examine the correlation between the results of the test and those of other tests measuring the same skill (convergent validity). As a result, the correlation of the results of the quick repetition test with those of the phonetic test [9] was investigated in the current study. The relevant results demonstrated a significant correlation, indicating an acceptable convergence validity of the scale (r_p=0.71, P≤0.05). Besides, the discriminant validity of different age groups is a construct validity type; it indicates the test's ability to differentiate various age groups based on the subjects' scores. Results of the inflated beta-binomial regression indicated a significant improvement of the test's performance with increasing age.

Comparing the scores of the normally-developing children and those with SSDs (clinical validity) suggested that the odds of correct responses in healthy-speaking children was about 1.3 times greater than that of the children with SSD (OR: 1.38; 95%CI 1.254218-1.526261 ; P<0.001).

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Table 1. Mean and standard deviation values of the quick repetition test in group 1

Age (y)	Number	Male	Female	% (of The Sample)	Mean±SD
3;00-3;11	20	10	10	4.77	34.45±5.84
4;00-4;11	21	10	11	5.01	38.00±5.30
5;00-5;11	29	21	8	6.92	42.27±2.23
6;00-6;11	153	80	73	36.51	43.31±1.96
7;00-7;11	89	54	35	21.24	43.61±1.31
8;00-8;11	107	66	41	25.53	43.60±1.60
Total	419	241	178	100	42.69±3.24

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Table 2. Mean and Standard Deviation scores of the quick repetition test in group 2

Age (y)	Number	Male	Female	% (of The Sample)	Mean±SD
3;00-3;11	11	6	5	30.6	24.90±8.56
4;00-4;11	10	10	0	27.8	28.20±8.08
5;00-5;11	4	4	0	11.1	32.25±7.32
6;00-6;11	7	5	2	19.4	31.85±4.77
7;00-7;11	4	3	1	11.1	32.50±5.56
Total	36	28	8	100.0	28.83±7.65

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Figure 2 illustrates the Bland-Altman plot demonstrating the scores of the quick repetition test and phonetic test. The relevant results indicated that at a 95%CI, the two measurements had an agreement range of 27-6.7, i.e. relatively low and acceptable.
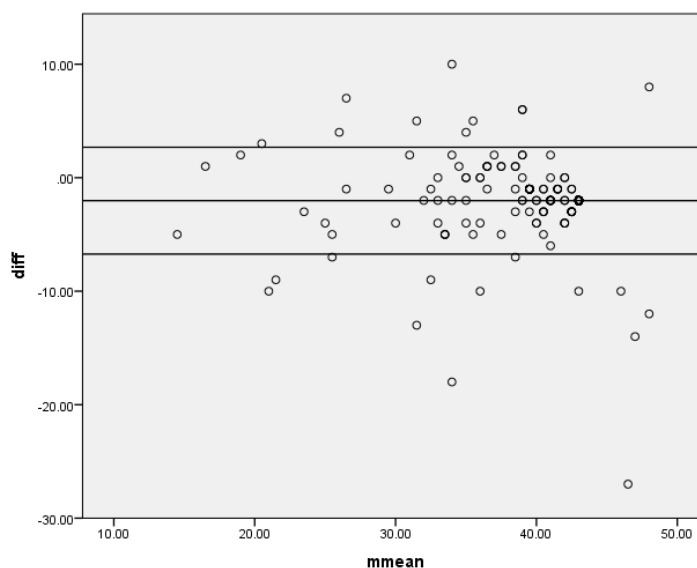
4. Discussion

The present study has targeted the development and psychometric validation of a quick repetition test. This scale was generated to assess speech sound abilities in

Table 3. Percentile ranks for the test's total scores

Age Group (y)	No.	Percentile Ranks						
		1	5	25	50	75	95	99
3;0-3;11	20	19	19	31	36	38	42	42
4;0-4;11	21	27	27	34	39	42	44	44
5-5;11	29	34	36	41	43	44	44	44
6-6;11	153	34	40	44	44	44	44	44
7-7;11	89	35	40	44	44	44	44	44
8-8;11	107	32	40	44	44	44	44	44

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Figure 1. The phonetic development of Persian-speaking children

☐ The age of mastery (>90% of children in an age group correctly utter the sound);

▨ The age of acquisition (>75% of children in an age group correctly utter the sound);

▨ The age of customary production (>50% of children in an age group correctly utter the sound);

■ The age of approximate production (<50% of children in an age group correctly utter the sound).

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Figure 2. The Bland-Altman plot of the screening repetition and corresponding target words of phonetic test scores

Persian-speaking children within the age group of 3;0-8;11 years. The test presented in this study can serve different purposes. Our proposed test requires a short time for administration (i.e. about 2 min); thus, it can be used as a quick speech test or in an early clinical assessment.

The proposed test was investigated among 419 children without any clinical signs of speech impairment and 36 children diagnosed with SSDs. The present study results suggested the acceptable reliability and validity of the quick repetition test.

The desirable internal consistency of the presented quick repetition test reflects that all items of the devised test were measuring the same performance [23]. Investigating the inter-rater reliability of the quick repetition test revealed an agreement rate of 99%, representing a strong concordance [24]. Therefore, our test can be applied by the clinicians, since it can produce consistent results without being affected by the examiners' bias. Considering the test-retest reliability, an agreement rate of 0.74% indicated the consistency of our proposed test over time; with little effect of the external factors of error and the same score for a participant, the same data would be obtained if being examined with the test several times [24]. The correlational results obtained for our test were in line with those reported for other instruments assessing speech sound [7-9, 14, 25, 26].

In the current study, the construct validity of the quick repetition test was determined by exploring its subtypes, namely discriminant validity and convergent validity.

Regarding the age group discrimination, the obtained results presented a high discriminant validity, and as expected, the test's scores increase with children's age.

The scale's convergent validity was examined by calculating the correlation between the scores of the quick repetition test and those of the phonetic information test, i.e. a comprehensive articulation test. The obtained result (r=0.71) indicated the overlap between the scores of the two tests. Accordingly, the quick repetition test can provide a profile of children's consonant inventory.

Additionally, our results indicated a significant difference between the scores gained by the children with SSDs and those obtained by their healthy age- and gender-matched counterparts. Consequently, our proposed quick repetition test has the potential to easily distinguish the children with speech sound impairments.

Our findings revealed a relatively strong correlation between the results of the phonetic information test and those of the quick repetition test. The phonetic information test is a picture-naming test, i.e. a detailed and common tool assessing speech abilities in children. Therefore, the correlation between the two tests supports the concurrent validity of our devised test.

In the current study, descriptive data were established through administrating the quick repetition test to a large group of Persian-speaking children (N=419). Comparing the data with the normative data reported in other studies investigating the children who speak other lan-

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guages suggests numerous similarities in speech development. For instance, consistent with other studies, Persian-speaking children acquire nasal consonants and frontal stop consonants sooner and affricatives and /s/, /z/, and /ʒ/ consonants later [8, 14, 27-29]. In the present study, the age for the mastery of the utterance of /s/ consonant was determined as 7;0-7;11 years, i.e. in line with the results reported by Poole [28], and Tresoldi [8].

The present study entailed several limitations. First, the number of children in different age groups was heterogeneous; due to the small size of some groups, normative data could not be reported and descriptive data were reported instead. Second, the size of the case group consisting of the children with SSD was relatively small. It is suggested to perform further studies using more homogeneous subgroups of children according to age to obtain normative data. Additionally, it is suggested to administer this test on children with SSDs of different severities and etiologies regarding the efficiency of quick repetition test in the diagnosis of speech impairment in children.

5. Conclusion

Like the Italian quick repetition test, the Persian quick repetition test proposed in the present study was a reliable and valid instrument facilitating the assessment of speech sound abilities. Moreover, the conciseness of this test makes it easily applicable in clinical practice as a screening test and epidemiological investigations. Furthermore, reported descriptive data from a large sample can facilitate the comparing of child speech ability to the speech development standards.

Ethical Considerations

Compliance with ethical guidelines

The current study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences (Code: IR.MUMS.REC.1398.071).

Conflict of interest

The authors declared no conflicts of interest.

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Appendix A. The quick repetition test for Persian-Speaking Children

Target words	Phonetic Transcription	Target Phonemes
روز	/ruz/	ri, zf
خواب	/xab/	xi, bf
میخ	/mix/	mi, xf
گچ	/gætʃ/	tʃf
لپ	/lop/	li, pf
توپ	/tup/	ti
بیل	/bil/	b I, lf
سوت	/sut/	tf
گوش	/guʃ/	ʃf
جیب	/dʒib/	dʒi
شیر	/ʃir/	ʃI, rf
نوک	/nok/	ni
چاق	/tʃaq/	tʃI, qf
نی	/nej/	jf
کیف	/kif/	ki, ff
گل	/gol/	gi
گاو	/gav/	vf
سگ	/sæg/	si, gf
زن	/zæn/	zi, nf
زود	/zud/	df
یک	/yek/	ji, kf
کاج	/kadʒ/	dʒf
ماه	/mah/	hf
فیل	/fil/	fi
در	/dær/	di
وان	/van/	vi
قم	/qom/	qi, mf
هیس	/his/	hi, sf
پاژ	/paʒ/	Pi, ʒf
ژل	/ʒel/	ʒi

Haresabadi F, et al. Quick Repetition Test for Persian-speaking Children. IRJ. 2020; 18(4):465-474.