

Case Report

Adaptation of the Syllable Repetition Task (SRT) and Determining its Validity and Reliability in 4-6 Persian-Speaking Children

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Objectives: This study aimed to evaluate the psychometric properties of the SRT that was performed in 4-6 year-old Persian-speaking children. The SRT is a nonword repetition task that assesses phonological working memory and was designed by Shriberg in 2008.

Methods: The present research was a non-experimental study with a methodological design. The content validity of the task was evaluated by 15 speech language pathologists (SLP). The Lawshe coefficient was acceptable, and therefore without changing the number and phonological structure of the nonwords, the SRT was performed by 140 normal children in two groups (4-5 and 5-6 years old) that were selected randomly from 10 kindergartens of Tehran. To assess the test-retest reliability, the SRT was performed at one-week intervals. Finally, to determine the differential validity of the SRT, the task was performed in 30 children with speech sound disorders (SSD) that had been selected from speech and language clinics of Tehran. SPSS software version 21 was used to determine the Pearson correlation coefficient, Cronbach's alpha coefficient and T-test.

Results: The CVR coefficient of the SRT was between 0.57 and 1. Cronbach's alpha coefficient of the total score was 0.83, and the Pearson correlation coefficient between successive runs was 0.87 ($P < 0.001$). There was a significant difference between the performances of two age groups ($P = 0.00$). Also, the SRT score in SSD children was significantly lower than in normal children ($P = 0.00$).

Discussion: The SRT appears to be a psychometrically valid and reliable nonword repetition task for evaluating phonological working memory. The evidence of the differential validity of the SRT was approved in two ways: Differences between two age groups of normal children and differences between normal and SSD groups. The poor performance of children with SSD indicates that these patients have difficulty to store and retrieve phonological information in their working memory.

Keywords: phonological working memory, Syllable Repetition Task, validity, reliability, speech sound disorders

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Introduction

Research on working memory and its role in learning and language development has increased significantly during the past twenty years. At first, the concept of multicomponent working memory was noted by Baddeley and Hitch in 1974 and, despite the passing of decades since, it is still one of the most prominent theories in this field (1). Phonological loop (articulatory loop) is the component of working memory specialized in processing and manipulating limited amounts of speech-based information and has two slave systems: the phonological short-term memory (phonological working memory) which is responsible for the temporary storage and processing

of phonological representations; and the articulatory rehearsal process that serves to maintain decaying representations in the phonological short-term memory (2,3). The most important tests for evaluating phonological working memory are nonword repetition tasks (NWR) (4). In these tasks, a real lexical item is replaced by a nonword, so the child can't use its previous lexical knowledge (5). For the first time in 1994, Baddeley and Gathercole developed the Children's Test of Nonword Repetition (CNrep) for 4-8 year-old English-speaking children. The content validity and test-retest reliability was used to determine the psychometric properties of the CNrep (6). After it, Santos developed the Brazilian

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Children's Test of Pseudoword Repetition (BCPR), a Portuguese language version of the CNRep in Brazil. The construct validity of BCPR was evaluated in comparison with CNRep and determined to be 0.50, while the test-retest reliability was 0.81 (7). Gardner in England and Ebert in America also designed other NWRs. The Cronbach's alpha coefficient in Gardner's study was reported as 0.72, and the reliability was 0.67, in comparison with the gold standard of CNRep (8). Ebert also used test-retest reliability, but didn't report any method for evaluating the validity of his test (9).

In Iran, two studies were conducted in relation to the designing of the NWR: Sayyahi and Afshar (10,11). In both studies, the psychometric properties of the tests were determined with test-retest reliability and content validity. Afshar's study was the first study in the evaluation of phonological working memory in speech sound disorders (SSD) by NWR. He showed that children with SSD have poor performance on these tests. However, there is ambiguity in this result. In this study, the phonological structure of nonwords may be too complex for SSD patients, so we don't know whether children have poor memory processes for repeating nonwords or if they simply cannot articulate nonwords because of speech motor problems. The Syllable Repetition Task is a nonword repetition task developed by Shriberg in 2008 for use in genetic and other studies that includes young speakers with limited phonetic inventories or speakers of any age with speech sound disorders of known or unknown etiology (5,12). The primary goal of this test is to provide a means to examine speech-processing constraints, while minimizing or eliminating speaker, scoring, and interpretive confounds associated with misarticulations (5). One problem for examiners was the difficulty to classify repetition errors in small children and speakers with speech and language disorders: should all errors be scored as repetition errors or as the target phoneme misarticulation, due to lack of maturation of speech processing (5)? For the examiner, speech production errors affecting the precision or intelligibility of responses pose psychometric challenges to the reliability and validity of nonword repetition task scores (5). The SRT includes 18 nonwords (eight 2-syllable (CVCV) items, six 3-syllable (CVCVCV) items and four 4-syllable (CVCVCVCV) items). Nonwords in the SRT consist of four anterior voiced consonants (/m/, /n/, /b/, /d/) and one vowel (/a/). Unlike the previous tests, the consonants of the SRT are salient,

available in the phonetic inventory of young children and most people with speech and language disorders. The three simple syllabic structures eliminate opportunities for respondents to delete final consonants or reduce clustering. This is another advantage of this test in comparison with other similar tasks. Additional considerations were that the two consonants in each manner and class were balanced as best as possible in their distribution within nonwords and across syllable levels. Also, the short time needed to complete this task minimizes the risk of fatigue in nonword repetition tasks (5). The SRT is able to identify any problems in the speech processing mechanisms such as auditory-perceptual processing, memory and motor planning-programming mechanisms. Shriberg argued that problem in these processing mechanisms can lead to failure of nonword repetition (5,12).

As far as we know, one of the characteristics of many standard tests is its cultural and linguistic factors; i.e. a test that has been standardized based on the cultural and linguistic factors of Western communities may not provide adequate reliability and validity for Persian-speaking people, unless the questions and items of the test were adapted to Iranian culture and then performed by sample groups of Persian people (13,14). Therefore, in this study, we aimed to adapt the SRT and determine its reliability and validity in 4-6 years Old Persian children.

Methods

Participants and procedure - 140 normal children and 30 children with speech sound disorders aged between 4 and 6 years old were selected, based on inclusion and exclusion criteria. In order to be included in this study, the child must be 4-6 years old, speak Persian and possess a normal IQ. The Goodenough-Harris Drawing Test was performed on each child to assess their IQ (15). If the score was between 90 and 110, the child was selected. Also, with reference to the child's medical history, hearing loss, neurological disorders, psychiatric diseases, chromosomal aberrations, all types of mental retardation, normal non-fluency (NNF) and stuttering were carefully examined. If any of these were approved by the speech language pathologist, the child was excluded from the study. The sample of normal children consisted of 70 children 4-5 years old (25 male and 45 female) and 70 children 5-6 years old (31 male and 39 female) who were randomly selected through multi-stage sampling from 10 kindergartens in the North, South, East,

West and central parts of Tehran. In children with SSD, simple random sampling was used to include 15 children who were 4-5 years old (9 male and 6 female) and 15 children who were 5-6 years old (7 male and 8 female) from speech language clinics of Tehran. A phonetic and phonological diagnostic test was carried out to diagnose SSD (16). If the percentage of correct consonant (PCC) score was lower than 90%, the child was selected. Finally, all participants signed an informed consent form approved by the Ethics Committee at the University of Social Welfare and Rehabilitation Sciences.

Instrument - The present research was a non-experimental study with a methodological design. First, a questionnaire was designed to evaluate the content validity of the SRT. It had 72 questions and was completed by 15 speech and language pathologists. Experts judged "Are all items of the SRT nonwords according to the phonological rules of the Persian language?" They also judged the ability of the SRT to evaluate auditory-perceptual processing, phonological working memory and motor planning-programming process. Results showed all items of the SRT are nonwords based on the phonological and phonotactic rules of the Persian language, and so this task has a content validity for assessing the auditory-perceptual processing, phonological working memory and motor planning-programming processes. So the SRT was confirmed without any changes to the phonological shape and structure of nonwords. The original audio file of the SRT was downloaded (<http://www.waisman.wisc.edu/phonology/>) and then copied onto an mp3 player (Sony model D620). To determine the validity of the original version, we used the opinion of 6 people, including 3 speech language pathologists, 1 linguist and 2 highly educated scholars of the Persian language. After determining the acceptability of the results, we decided to use the original version of the test to

perform on children. The environment of the test was a room with a table and two chairs. The examiner sat down in front of child without her/his mother or teacher. Factors such as the temperature of the room, the absence of noise and any objects that might disrupt the child's concentration, such as large color pictures were thoroughly checked by the examiner.

After coordinating with parents and written consent, the SRT was performed on the children. Each child carefully listened to the audio file of the SRT. After hearing each nonword, the child had 4 seconds to repeat it. According to the instructions of the SRT, correct repetition had a score of 1, and an incorrect repetition scored 0. Any distortion of nonwords was considered correct while substitution was considered an incorrect repetition. Results were recorded on the scoring form which consisted of correct and incorrect repetitions, and a transcription of each nonword. In order to evaluate the test-retest reliability, the test was performed at one-week intervals on normal children. SPSS software version 21 was used for all calculations, including descriptive statistics (frequencies, means, standard deviations, etc.), inferential statistics (coefficient Pearson's correlation, T test) and conventional methods in psychometry such as Cronbach's alpha coefficient.

Results

In this project, 15 speech-language pathologists determined the content validity of the test. If the CVR coefficient of any question was greater than 0.51, the item was considered acceptable (17). The Lawshe coefficient of all nonwords was calculated as being between 0.57 and 1 (Table 1). To evaluate the reliability of the SRT, the test-retest method with one week intervals was used. The Pearson correlation coefficient was calculated between successive runs 0.87 (P<0.001).

Table 1. Mean and Standard deviation of normal children in the SRT

age group	N	Mean	Std. Deviation	Std. Error Mean
4-5 years	70	12.71	3.52	0.42
5-6 years	70	15.61	2.73	0.32

To assess the internal consistency of the SRT, Cronbach's alpha coefficient was 0.83. In order to determine the differences between the two age groups in the SRT, the Levine test was used to assess the equality of variance between groups.

Results indicated that Levine was significant (P>0.05). The T-test was used to analyze data. Results listed in table (2) show the T score is significant and equal to -5.43 (P=0.00, T=-5.43).

Table 2. Comparison of the performance of normal children (4-5 & 5-6 years) in the SRT

	Levine's Test for Equality of Variances		T-test for Equality of Means						
	F	Sig.	t	Sig 2.tailed	df	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	6.08	0.01	-5.43	0.00	138	-2.90	0.53	-3.95	-1.84
Equal variances not assumed			-5.43	0.00	129.97	-2.90	0.53	-3.95	-1.84

In another phase, the performance of two groups (normal children and children with speech sound disorders) was analyzed. The Levine test for equality of variances was initially examined. Results indicate

that Levine is significant ($P > 0.05$). T-test was used to analyze the data (table 3). Results that are listed in table (4) show that the T score is significant and equal to 4.76 ($P = 0.00$, $T = 4.76$).

Table 3. Mean and Standard deviation of normal and SSD children in the SRT

group	N	Mean	Std. Deviation	Std. Error Mean
Normal children	140	14.16	3.46	0.29
SSD children	30	10.86	3.31	0.60

Table 4. Comparison of the performance of normal and SSD children in the SRT

	Levine's Test for Equality of Variances		T-test for Equality of Means						
	F	Sig.	t	Sig 2.tailed	df	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	0.00	0.95	4.76	0.00	168	3.29	0.69	1.93	4.66
Equal variances not assumed			4.90	0.00	43.63	3.29	0.67	1.94	4.65

Discussion

One purpose of the present study was the adaptation of the syllable repetition task. As the phonological and syllabic structures of all the items of the SRT were available in the Persian language and, according to the opinion of speech and language pathologists, all the items of the SRT were nonwords, this means that the SRT was perfectly adapted to Persian language rules. In this study, two methods were used to evaluate the validity of the SRT; the content and differential validity. Evaluating content validity is the first step for all measures (tests, scales, questionnaires, etc.), and all items are fundamentally collected after proving their content validity (11,14). We used the Lawshe coefficient to determine the content validity of the SRT. According to the judgment of experts, all nonwords of the SRT have content validity to evaluate phonological working memory. The differential validity of the SRT was assessed by comparing the performance of two age groups (4-5 and 5-6 years old) of normal children. Results showed that there was a significant difference

between the performances of the two age groups. As children grow up, they show improvements in the speed and capacity of their working memory. When children grow up, they can search through data from their memory faster than previously, because their knowledge of encoding and retrieving data is increasing. In fact, children acquire more knowledge and complex concepts with aging (18,19). Another aim of this study was to compare the performance of normal children and children with speech sound disorders in the SRT. Results indicated that there was a significant difference between the performances of these groups. The findings of this study showed that children with SSD have a poor ability to repeat nonwords, compared with normal children. Munson and colleagues believe that auditory-perceptual encoding deficits may be the source of speech production errors in speech sound disorders (20). Van der Lely and Howard argue that output constraints on speech production might affect the ability of speech-disordered children to imitate nonwords (21). However, regardless of the cause of the repeated failures in these children, the results are

consistent with results of Carroll and Snowling, Tkach, Liwis and Afshar which already showed poor performance of children with SSD in nonword repetition tasks (10,22-24).

In order to evaluate the reliability of the SRT, internal and external consistency was measured by calculating Cronbach's alpha coefficient and test-retest reliability. Baddeley and Gathercole, Santose, Ebert, Sayyahi and Afshar used test-retest reliability in their studies. The American Psychological Association believes that a correlation coefficient between 0.75 and 0.90 is sufficient to confirm test-retest reliability (11). Also, Cronbach's alpha coefficient between 0.70 and 0.80 is enough for tests that were made for research purposes (14). Therefore, with regard to test-retest reliability and Cronbach's alpha coefficient, it seems the SRT has reasonable reliability.

Results indicated the SRT has high validity and reliability in Persian language to evaluate phonological working memory. The significant difference in the performance of two age groups can be considered as the differential validity of the SRT.

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Significant differences between performance of normal children and children with speech sound disorder showed that these children have difficulty in storing or retrieval of new phonological sequences in memory that may underlie articulation disorder. We suggest that complementary studies should be done by using the SRT to identify processing problems that underlie speech and language disorders such as auditory-perceptual or planning-programming processing disruptions. More studies can be performed with greater sample sizes and different accents and languages to confirm the capabilities of the SRT in diverse cultures.

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