Research Article

Developing a Morphological Awareness Test and Determining Its Psychometric Properties for Persian-Speaking Students

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ABSTRACT

Introduction: Morphological awareness (MA) refers to the ability of conscious manipulation of morphemes (minimal meaningful units of language). There is no test for assessing MA in Persian. Therefore, this study aims to develop a morphological awareness test (MAT) and determine its psychometric properties in elementary school students.

Materials and Methods: This methodological research study was performed in 2 phases. The first phase of the current study involved studying articles to extract Persian morphemes for designing a MAT. A draft of MAT was developed. In the second phase, to determine content validity, the MAT was given to 7 experts. The content validity ratio and content validity index (CVI) were calculated. Intra-class correlation and Cronbach alpha were calculated for determining test-retest reliability and internal consistency, respectively. To determine discriminant validity, 20 dyslexic students were compared with 31 normal readers using the Mann-Whitney U test.

Results: CVI was reported 0.94. Test-retest reliability results showed that there were statistically significant differences ($P<0.005$) between two times in 7 subtests out of 10. Internal consistency was reported as 0.70. The results of discriminant validity showed that there was a statistically significant difference between normal and dyslexia groups in all MA subtests ($P<0.005$).

Conclusion: The amount of CVI showed that the test can examine MA skills. The inconsistency between test-retest results proved the influence of experience. The internal consistency of the test was acceptable. The appropriate discriminant validity results showed that the test can distinguish between normal and dyslexic groups. Therefore, the Persian MAT is a valid and reliable tool for the assessment of MA skills.

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1. Introduction

Morphemes (prefixes, suffixes, and root of words) are described as the smallest meaningful units of language. Morphological awareness (MA) refers to the ability to consciously manipulate morphemes [1]. There are 3 kinds of morphemes in English including derivational, inflectional, and compounding [2]; the same holds for Persian [3]. MA develops through gradual exposure to words and morphemes in different contexts [4]. MA emerges at a simple level in the preschool stage and it gradually continues to develop in the elementary stage. It is evident that students act perfectly in the last year of elementary school [5]. Three kinds of MA are developed through the third and fourth grades, just derivational morphology and high-level structures continue to develop even after the fourth grade [6]. At the beginning of the word reading phase, students convert graphemes to phonemes. In this stage, MA doesn't play an essential role in learning to read, because students learn mono-morphemic words [7], but parallel to enhancement in the educational level, considering memory and time load, grapheme to phoneme conversion is not optimal. Therefore, students learn to read the whole morpheme, instead of focusing on phoneme representations of graphemes [8].

Morphological rules are different according to diversity in languages orthographies. English orthography is mostly considered morphophonemic in which some words are pronounced by letter-to-sound patterns [9]. Persian is a mono-morphemic [10] and semitransparent language with difficult orthographic rules [3, 11]. Persian morphological system, like English, is composed of inflectional, derivational, and compound words. The frequency of different kinds of morphemes varies in different languages [3]. The morphological diversity is also evident in Persian. Most of the morphemes in Persian are derivational, and a few are inflectional [12]. An example of an inflectional morpheme in Persian is "ha" for plural names (/gol/+/ha/=/golha/, "flowers"). There are 6 personal inflectional suffixes for verbs; they are attached to the end of the verbs to show agreement between the subject and the verb. In the following examples, they are underlined (/xordæm/ "I ate", /xordi/ "you ate", /xord/ "she/he ate," /xordim/ "we ate," /xordid/ "you ate," and /xordænd/ "they ate.") [2, 3]. Moreover, there are 75 derivational suffixes in Persian, such as; /kar/ in /setæmkar/ "cruel" and /ar/ in /ræftar/ "behavior"[13].

There is an abundant body of evidence that confirms MA is related to reading ability [14, 15]. Berninger et al. showed that MA, via recognition of morphemes, plays an important role in learning to read; this is done through word decoding and word reading [15]. Morphological knowledge is essential for the interpretation and learning of new words in both spoken and written languages [16]. The recognition of affixes and understanding of their meanings facilitates the development of vocabulary. It also accelerates prosperous comprehension during reading. MA facilitates correct word identification which is a necessary step in the comprehension process [16]. Students who achieve higher scores on the morphological awareness test (MAT) reach advanced levels in reading and writing tasks across all educational grades [17]. The relationship between MA and reading and the influence of MA on reading have been investigated in English and other languages. These studies revealed the correlation between MA and reading in most languages [18-20].

According to the purposes of research in the MA domain, various tasks have been used in different studies. Some of these tasks were presented orally [21] and others in written form [22]. The methods of answering questions were different including selecting one option among multiple choices [23], filling in the blanks [24], judging the correct or incorrect morphological structures [25], and developing a new morphological structure [26]. Some tasks contain words [26, 27] and the other tasks have non-word items [25]. Despite various studies in the field of MA, there are some limitations as well. Based on the review f the literature, the MA tasks were constructed by researchers who had not paid any attention to calculating psychometric properties such as validity and reliability. Each study introduced a few tasks and there is no comprehensive test for MA evaluation.

Using a valid and reliable test is necessary for clinical and research domains. If the test is not developed properly, incorrect information and decision-making will be presented [28]. A reliable and valid test is needed to measure the integrity and consistency of an ability. For example, if there is no proper tool for evaluating MA skills, there is no validity for MA evaluation. In this way, the examiner evaluates MA skills based on personal opinion. The lack of a valid and reliable test leads to several conclusions about the sole ability [28].

Due to the importance of MA in reading and the lack of a reliable tool for measuring MA ability, we had two purposes for this study. First, we aimed to develop a MAT based on Persian morphological properties (a complete test for the assessment of derivational, inflectional, and

compounding morphemes). Second, we aimed to determine the psychometric properties of MAT including content validity, test-retest reliability, internal consistency, and discriminant validity in Normally Developing (ND) readers.

2. Materials and Methods

To develop the MAT, a methodological research method was used.

Participants

To determine content validity, 7 experts (including 3 speech-language pathologists and 4 linguists) participated in this study. To calculate the test-retest reliability and internal consistency, 31 ND readers (19 male) (age Mean±SD: 9.11±1.45 years) participated. The inclusion criteria included lack of hearing impairment, uncompensated visual deficit, neurologic and speech/language difficulties, lack of educational deprivation in the third and the fourth grades, not being failed at any grade, and having a normal intelligence quotient [29], and reading skill [30]. All of the participants were monolingual native speakers of Persian. Finally, to determine the discriminant validity, the performance of 31 ND readers and 20 dyslexic students (age Mean±SD: 9.66±1.11 years) in MA ability were compared. The inclusion criteria for dyslexic students were similar to ND readers except for having reading deficits according to the teacher questionnaire [31], and the Nema reading and dyslexia test [30]. ND readers were selected from the classes in which dyslexic students were educated and were matched based on educational grades.

Instruments

In the current study, 4 tools were used. These materials are introduced below:

Wechsler intelligence scale for children (WISC-R)

The non-verbal section of the WISC-R test was used to determine participants' intelligence quotient. The non-verbal section has 5 subtests including digit span, animal house-coding, picture completion, mazes, and block design. The test-retest reliability of WISC-R is 0.44 to 0.94. Moreover, its concurrent validity is 0.74 [29].

Teacher questionnaire

The teacher questionnaire has 7 questions completed by teachers. If all the answers were negative (from 7 questions), the student was considered an ND reader. If 3 and more of 7 questions of the teacher questionnaire were positive, the students were sent for further evaluation because they might be a dyslexic students. The questions gather information on reading, writing, spelling, handwriting, memory problems, behavioral and emotional issues, organization, and time management [31].

Nema reading and dyslexia test

In this study, reading skill was assessed by the Nema test. The subtests of this test are real word reading, non-word reading, word chain, rhyme detection, picture naming, phoneme deletion, word comprehension, text comprehension, and letter and category signs. The internal consistency for the Nema test subtests is between 0.93 to 0.98.

Morphological awareness task (MAT)

The MAT developed in this research has 10 subtests. Each subtest has 10 questions (a total of 100 questions). The scoring is dichotomous (1 for correct and 0 for incorrect answers). Sub-tests of MAT are as follows:

The MA task: This task was a verbal multiple-choice recognition task, in which participants were asked to complete sentences by choosing the most appropriate morphological form from 4 alternatives. Half of the questions are words and the other half are non-words. All of the items have derivational morphemes [23].

Example: pedære ʔæl isaxtemansazi mikonæd. ʔu___ æst. A. kar B. karxane C. kargar D. kargardan. (Ali's father builds a home. He is a ___. A. work B. workplace C. worker D. working).

Dynamic morpheme production task: In this written task, students must complete sentences by adding affixes to words or non-words which were underlined. Half of the questions are words and the rest are non-words. Affixes include both inflectional and derivational morphemes [25].

Example: ʔin yek ʔadʒor ʔæst. ʔin xane ʔadʒori æst (this is a brick. This is a brick house).

Comes from task: In this task, students should decide whether the second word is derived from the first word. This task was administered in verbal form [25, 32-34].

Example: Zibaei ʔæz ziba gerefte ʃode ʔæst, ʔya pedær ʔæz ped gerefte ʃode æst (Beautifully comes from beautiful, Dose father come from fath?).

The sentence analogy task: Participants must draw an analogy between sentences. Sentence "a" corresponds with sentence "b" and sentence "c" corresponds with sentence "d." This task was presented in verbal form and the student answered verbally [35].

Example: a) mænmixoræm b) to xordi c) mænmibinæm d) …… (Correct answer: to didi).

a) I eat b) you ate c) I see d) …. (Correct answer: you saw).

Relative task: In this task, the participants were given a base word, then were asked to complete sentences orally with a derivational or inflectional form of the base. The task was administered in verbal forms [21].

Example: karkærdæn. Pedære ʔæli hær ruz dær bimarestan …. Correct answer: kar mikonæd (to work. Ali's father is in the hospital every day. Correct answer: works).

Morpheme identification task: This orally administered task evaluates the ability to distinguish 2 different meanings of homophones. Oral explanations about the word's meaning were provided for each item, and then presented one combined word which constructed with one of the homophones to the participants. Students must tell which word exists in the combined word [26].

Example: sæd (100) – sæd (dam). Correct answer: sædbænd. The words a dam and number 100 were defined for the child and asked: "a new word of "sædbænd" contains which word a dam or number 100? ." Correct answer: sad (dam)."

The morphological structure awareness: This is an orally administered task that evaluates the ability to combine morphemes to construct a new odd word with a new meaning. Two sentences were presented to students. There was a word in the first sentence and there was one blank in the second sentence. This blank must be completed with a change in the presented keyword in the first sentence [26].

Example: ʔæli hær ruz sobh sobhane mixoræd ʔuzohrha …mixoræd. Correct response: zohrane. (Ali eats breakfast every morning. He eats at noon__. The correct response was noonfast).

The morphological spelling task: In this task, words with prefixes and suffixes are read. This task aims to get students to use their morphological knowledge for word spelling. The words were selected according to the educational curriculum of elementary students [36].

Example: namolayemat (harshness).

The task of morphological decomposition: In this task, one sentence with one blank and one morphologically derived form as a keyword was presented. Students must complete sentences with the base form of a keyword. The task was administered verbally [21, 37].

Example: The word is "dorughgu (liar)." The sentence is: moællem be ʔæli goft "…."xubnist (the teacher told Ali is not a good thing). (Correct answer: dorughii (lying).

Construct formation task: In the current task, participants were asked to identify the correct construct formation between 2 choices that would be according to the given definition for each correct structure [27].

Example: "xaneyegeli," rather than "gel xane" ("mud house" rather than "the house made of mud.")

Procedure

The present study was performed in two stages. In the first stage, MAT was developed and the psychometric properties of MAT were evaluated. In the second stage, the content validity, test-retest reliability, internal consistency, and discriminant validity were computed.

Developing the MAT

Twenty-two MA evaluation tasks were extracted from the literature [8, 18, 21, 24, 27, 36, 38-41]. Persian literature and Persian reading books for elementary grades were studied to obtain common Persian morphemes [12, 13]. Among obtained morphemes, the highly frequent morphemes in elementary school reading books were selected for using test items. Ten tasks (14 questions for each task) were selected for the assessment of MA. MAT was developed based on Persian morphology properties. It is noteworthy that 12 tasks from 22 obtained tasks were excluded because their aims were similar to 10 tasks that were selected finally.

Psychometric properties of the test

To determine content validity, MAT was given to 7 experts. According to the Lawshe formula, there are 3

options for each question. These options included: "necessary", "useful but unnecessary", and "unnecessary." [42] The expert panel should qualitatively choose one of the above-mentioned options for each question. Accordingly, only questions that score as "necessary" are considered for content validity calculations. It is noteworthy that CVR was calculated for each question separately. When 7 experts participate in the calculation of content validity, the acceptable score for each question is considered 99% [42]. The basic version of the MAT including 140 questions was given to the expert Panel. After giving the test to experts, 40 out of 140 questions were removed. To calculate test-retest reliability, MAT was executed twice with a 1-week interval on 31 normal participants. The internal consistency of the test was calculated using the Cronbach Alpha coefficient. The discriminant validity of MAT was calculated by comparison of MA skills between 31 ND and 20 dyslexic readers.

Statistical analyses

To calculate CVR Lawshe formula was used. According to Lawshe, the CVR amount for a 7-expert panel would be 0.99(42). The Content Validity Index (CVI) was obtained from the mean of the CVR values of all questions [42]. According to Waltz et al., the appropriate amount of CVI is 0.79 [43]. To calculate test-retest reliability, the Intra-Class Correlation (ICC) was used. Internal consistency was determined by the Cronbach Alpha. An appropriate value of both ICC and Cronbach Alpha was considered to be 0.70 [44, 45]. The normal distribution of data was assessed with a one-sample Kolmogorov-Smirnov test. Because the data were not normally distributed (P>0.005) Mann Whitney U test was used to compare MA skills in both groups of children. The significance level was ≤0.005.

3. Results

Content validity

CVR was calculated for 100 questions in 10 tasks, separately (Table 1). CVR was 0.42 and 1. CVI was 0.94.

Test-retest reliability: A statistically significant difference was found between participants' scores in 7 subtests of MAT at 2 different evaluation times. Only in 2 subtests of MAT, a statistically significant difference was not found (relative task [P=1.00] and task of morphological decomposition [P=0.489]). Table 2 shows the mean and standard deviation of students' scores in the 2 times. In all subtests, the mean of normal students' scores the second time was greater than the first time. Cronbach's results showed there is an acceptable internal consistency in the total score of MAT, and nearly an acceptable internal consistency for each task of MAT (r=0.70) (Table 2).

Comparison between two groups of students: The descriptive data of 31 ND readers and 20 dyslexic students is presented in Table 3. The MAT scores of ND readers were significantly higher than the MA scores of dyslexic students (P≤0.005). Table 4 shows discriminant validity data.

4. Discussion

The major aim of the current study was to develop the MAT and determine its psychometric properties includ-

Table 1. Content validity ratio for each question of MAT

Subtest	CVR=0.42	CVR=0.71	CVR=1
	QN	QN	QN
MA	7	2,5,6,8,9,10	1,3,4
Dynamic morpheme production	6,7	5	1,2,3,4,8,9,10
Comes from	-	3,8	1,2,4,5,6,7,9,10
The sentence analogy	-	9	1,2,3,4,5,6,7,8,10
Relative	-	-	1-10
Morpheme identification	-	10	1-9
Morphological construction	-	2,8	1,3,4,5,6,7,9,10
The morphological spelling task	-	-	1-10
The task of morphological decomposition	-	-	1-10
Construct formation	-	2,8	1,3,4,5,6,7,9,10

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QN: Question number; CVR; Content validity ratio; MA: Morphological awareness; MAT: Morphological awareness test.

Table 2. Intra-class correlation between the first and the second time of test execution and cronbach alpha in normal students (n=31)

Subtests	ICC	Sig.	Mean±SD		Cronbach Alpha
			First Time	Second Time	
The MA task	0.49	0.032	8.48±1.02	9.29±0.82	0.65
Dynamic morpheme production task	0.89	0.000	8.74±1.61	9.16±1.18	0.63
Comes from task	0.59	0.009	8.90±1.37	9.12±1.25	0.68
The sentence analogy task	0.86	0.000	0.09±1.19	9.25±1.15	0.69
Relative task	0.37	0.100	8.80±1.22	9.35±0.91	0.65
Morpheme identification task	0.52	0.023	9.09±1.13	9.03±1.22	0.70
The morphological structure awareness	0.47	0.044	8.58±1.47	8.96±1.27	0.65
The morphological spelling task	-	-	9.93±0.24	10±0.00	0.71
The task of morphological decomposition	0.01	0.489	9.25±1.82	9.96±0.17	0.73
Construct formation task	0.46	0.047	9.61±0.66	9.74±0.44	0.69
The total score of MAT	0.87	0.000	91.40±6.63	93.90±5.26	0.70

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ICC: Inter-class correlation; SD: Standard deviation; MA: Morphological awareness; MAT: Morphological awareness test.

ing content validity, test-retest reliability, internal consistency, and discriminant validity.

The MAT had content validity. The expert panels' scores represented that 82 out of 100 questions of the test have an acceptable level of CVR. Since all of the questions were selected based on resources and some experts considered all of the 100 questions as "necessary," the other 18 questions were included in the test as well. Having content validity for a test means that it can perfectly evaluate the skill which is developed for assessment of it [42]. Since the experts agreed with the suitability of the questions, the MAT can well capture and represent the MA ability in ND students in a well-defined way. The present study calculates the content validity that is absent in other related studies [8, 36, 38, 40, 46, 47].

Students performed differently in the test and retest for most subtests and the total score of MAT. It can be concluded that students' scores were affected by experience and learning effects. The results showed that mean scores in the second execution time were greater than the mean scores in the first time in all subtests. The length of time between sampling executions is one of the factors that can influence the reliability of results [28]. Short time interval leads the examinee to become familiar with the questions and to provide a better/different response to them the second time. Because of time constraints, one week for the execution of the retest was considered. McCutchen and Stull studied

Table 3. Descriptive data of students with dyslexia (n=20) and normally developing readers (n=31)

Subtests	Dyslexia Students			Normal Students		
	Mean±SD	Min	Max	Mean±SD	Min	Max
The MA task	6.70±1.62	4	9	8.47±1.18	5	10
Dynamic morpheme production task	4.65±1.98	1	10	8.70±1.60	5	10
Comes from task	5.30±2.02	2	10	9±1.37	5	10
The sentence analogy task	6.30±1.94	0	9	8.94±1.22	6	10
Relative task	6.50±1.98	2	10	8.94±1.20	6	10
Morpheme identification task	6.30±1.94	2	10	9.08±1.08	6	10
The morphological structure awareness	4±1.89	0	7	8.64±1.43	5	10
The morphological spelling task	4.60±2.34	0	7	9.88±0.32	9	10
The task of morphological decomposition	7.25±2.12	2	10	9.94±0.23	9	10
Construct formation task	8.25±1.65	4	10	9.61±0.65	8	10
The total score of MAT	60.20±11.07	25	77	91.44±5.88	80	100

SD: Standard deviation; MA: Morphological awareness; MAT: Morphological awareness test.

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Table 4. Mann–Whitney U Test for comparison of mean scores of dyslexia (n=20) and normal students (n=31) in MAT

Task	z	Sig. (2-tailed)
The MA task	-3.73	0.000
Dynamic morpheme production task	-5.29	0.000
Comes from task	-5.22	0.000
The sentence analogy task	-4.97	0.000
Relative task	-4.25	0.000
Morpheme identification task	-4.98	0.000
The morphological structure awareness	-5.87	0.000
The morphological spelling task	-6.70	0.000
The task of morphological decomposition	-5.95	0.000
Construct formation task	-3.55	0.000
The total score of the MA test	-6.09	0.000

MA: Morphological awareness; MAT: Morphological awareness test.

MA test-retest reliability as well, but they found children gained more scores in the first administration (r=0.73) [24]. This difference can be due to the longer interval in the second time of their test execution (3 months) and the larger sample size (n=171). Internal consistency characterized by using Cronbach Alpha is a conventional type of reliability determination and is considered as a necessary and sufficient condition for assessing tools' reliability [45]. According to Nunnally and Bernstein Cronbach's Alpha coefficient higher than 0.7 is considered appropriate and it represents the consistency and coherence of a test [45]. In the current, study 3 tasks of MAT and total score have acceptable internal consistency (above 0.70) and other subtests' internal consistency are near this limit (above 0.65). Since the internal consistency of all subtests is not above 0.70, the results of the consistency of the questions should be interpreted cautiously. This information is similar to the results of other studies that have examined the Cronbach Alpha of the MA assessment tasks [8, 38].

The mean scores of the dyslexic students were significantly lower than the mean scores of normal students. This significant difference between the 2 groups showed that MAT can well distinguish the 2 groups [48]. Such results are consistent with another study in which the dyslexic group systematically perform weaker than the normal one [36]. MA in dyslexic students does not grow naturally. Casalis et al. claimed that in morphological analysis tasks, with no context cue, the dyslexic group had a weak performance [49]. Based on the results of the present study, the morphological decomposition test and construct formation subtests obtained the highest scores in normal and dyslexic groups, respectively. The MA and the morphological structure awareness subtests obtained the lowest scores in the normal and dyslexic groups, respectively. Compared to ND readers, several factors influence the appropriate performance of the MA test in dyslexic ones. First, this performance is related to the phonological abilities of ND children. According to the phonological mapping theory, phonological skill plays a key role in morphological knowledge formation [50]. When normal children learn lots of complicated words, strong phonological skill helps them to identify and process morphological rules and morphemes [50]. Second, MA is an essential part of vocabulary knowledge and may be assumed an additional aspect of a student's depth of knowledge [40]. Strong word knowledge increases students' performance on morphological tasks that contain real words [51]. In the present study, normal students had the lowest performance in the MA subtest which included on-word items (half of the subtests). That is, vocabulary knowledge did not play a role in these subtests. In the current study, the lowest performance in dyslexic readers was related to the construct formation subtest (word building). According to Wysocki and Jenkins, the other diverse aspects of MA play an essential role in word-building impairment in the dyslexic group [52]. That is, dyslexic students have difficulty in generalizing the morphemes (using stem/root form and constructing new form) [52].

There were several limitations in the current study, including a short time interval between test and retest, a lack of examining the other psychometric properties (different types of validity and reliability), and standardization of the test. It is recommended that other psychometric properties be considered in future studies. Cut-off points and standardized scores were not achieved in the current study. Further investigations should be performed on a larger sample size of students in several grades.

5. Conclusion

Since there is no instrument to evaluate MA, one of the most important characteristics of the MA test is its novelty in evaluating MA characteristics of Persian -speaking students. The results represented that the MA test is a valid and reliable instrument that exclusively evaluates the morphological properties of Persian-speaking students. The MA test has 10 subtests (100 questions) and identifies the strengths and weaknesses of students in MA ability.

Ethical Considerations

Compliance with ethical guidelines

The ethics committee of Tehran University of Medical Sciences approved this study (Code: IR. TUMS. FNMREC.1396.3167).

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Authors' contributions

Conceptualization: Zahra Soleymani, Seyyedeh Samaneh Mirahadi; Methodology: Zahra Soleymani, Seyyedeh Samaneh Mirahadi, and Elham Alayiaboozar; Investigation and writing the original draft: Seyyedeh Samaneh Mirahadi; Writing, review, and editing: Zahra Soleymani and Elham Alayiaboozar; Supervision: Zahra Soleymani.

Conflict of interest

The authors declare no conflict of interest.

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