

Arabic psycholinguistic screening tool: a preliminary study

Azza Adel Aziz^a, Elham Ahmed Shaheen^a, Dalia Mostafa Osman^a
and Ahmad El Sabagh^b

^aPhoniatric Unit, ENT Department, Faculty of Medicine, Cairo University and ^bHearing and Speech Institute, Cairo, Egypt

Correspondence to Dalia Mostafa Osman, Phoniatric Unit, ENT Department, Faculty of Medicine, Cairo University, Cairo, Egypt
Tel: + 0106337599; fax: + 02 23642124;
e-mail: dmostafa9999@yahoo.com.

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Background

Psycholinguistics or the psychology of language refers to the study of the psychological and neurobiological factors that enable humans to acquire, use, and understand language.

Objectives

This work aimed at designing and applying an Arabic Psycholinguistic Screening Tool on a group of native Egyptian students aged 7 through 9, 11 years old, enrolled in primary grade 1 through primary grade 4, and analyzing the obtained results in order to attain a better understanding of psycholinguistic skills in the studied age range and preliminarily study the constituent items of the tool.

Participants and methods

The sample in this study included 45 healthy native Arabic-speaking Egyptian children: 25 boys and 20 girls. The groups were as follows: group I (from 7 to 7; 11 years old), group II (from 8 to 8; 11 years old), and group III (from 9 to 9; 11 years old). They were attending regular classes in schools following the Egyptian Arabic National curriculum. The participants were enrolled in primary grade 1 through primary grade 4. Children were randomly selected from a cluster of children reported to be subjectively free from any hearing difficulties, delayed language development, medical problems, and intellectual, social, psychiatric, psychological, or serious academic difficulties. Psycholinguistic abilities for each child were evaluated using the Arabic Psycholinguistic Screening Tool designed in the current study. Tested parameters included oral similarity, morphological closure, proper word and nonsense word repetition, phonological deletion, phonological rhyming awareness and production, spoken and written vocabulary, sequencing events, sight and sound decoding, in addition to sight and sound spelling. The results obtained were then analyzed using descriptive, comparative, correlation, reliability, and validity studies.

Results

The results reflected internal consistency as well as the content, construct, and convergent validity of the Psycholinguistic Screening Tool for children aged 7 through 9; 11 years for those items covering oral similarity, morphological closure, proper word repetition, spoken and written vocabulary, proper word repetition, spoken and written vocabulary, sequencing of events, sight and sound decoding, and sound spelling. Although nonsense word repetition, sight spelling, phonological rhyming awareness, and production subtests were found to have convergent validity as well as internal consistency, statistical studies did not quite prove their construct validity.

Conclusion and recommendations

(a) The phonological rhyming awareness and production as well as nonsense word repetition and sight spelling subtests should be revised taking into consideration the Arabic educational curriculum applied in Egyptian schools. (b) Further studies should be carried out on the Arabic Screening Tool to study predictive validity on a larger group of children. (c) Studies should be carried out using the Arabic Psycholinguistic Screening Tool on a group of children with learning disabilities to examine its diagnostic sensitivity.

Keywords:

developmental psycholinguistics, psycholinguistic assessment, psycholinguistic screening, psycholinguistics, psycholinguistics in Arabic language

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Introduction

Psycholinguistics or the psychology of language refers to the study of the psychological and neurobiological factors

that enable humans to acquire, use, and understand language. It is concerned with the nature of the computations and processes that the brain undergoes to comprehend and produce language. It covers the cognitive processes that

make it possible to generate a grammatical and meaningful sentence out of vocabulary and grammatical structures, as well as the processes that make it possible to understand utterances, words, text, etc. [1].

Psycholinguistics is interdisciplinary in nature. It can be studied by researchers in a variety of fields, such as psychology, linguistics, and cognitive science. Linguistic-related areas include phonetics and phonology (concerned with the study of speech sounds), morphology (the study of word structure, especially the relationship between words and the formation of words on the basis of rules), syntax (the study of the patterns which dictate how words are combined together to form sentences), semantics (which deals with the meaning of words and sentences), and pragmatics (which is concerned with the role of context in the interpretation of meaning) [2].

Typical development of psycholinguistics in a child can considerably help in his learning process. All language parameters, namely phonology, morphology, syntax, semantics, and pragmatics, play a major role in the proper development of reading and writing skills needed for learning process and academic achievement [3].

Study of psycholinguistic abilities in children can be carried out using behavioral quantitative studies. In these studies, participants are presented with some form of linguistic input and are asked to perform a task (e.g. make a judgment, reproduce the stimulus, or read a visually presented word aloud) [4].

Linguistic tasks that can be used to study developmental psycholinguistics include oral similarity, syntactic closure, proper word and nonsense word repetition, phonological deletion, phonological rhyming awareness, phonological production, sequencing events, spoken and written vocabulary, decoding (by sight/sound), and spelling (by sight/sound) [5].

Oral similarity refers to the similarity between like features of two things on which a comparison may be based [3]. In contrast, syntactic/morphological closure is the branch of linguistics that deals with word structure and functional changes in word forms [6].

Proper word and nonsense word repetition refers to the use of word imitation techniques to assess children's auditory-verbal sequential memory [7]. Phonological deletion means elision or omission of a vowel, consonant, or syllable in pronunciation, whereas phonological rhyming refers to the ability to identify as well as produce words that have corresponding sounds, especially terminal sounds [8].

The ability to organize events in sequence, sentence by sentence, is necessary to discriminate between normal and poor readers [9]. Decoding is the activity of converting code into plain text [8]. Sight decoding refers to the ability of the child to pronounce exception words that contain unwritten sounds or silent letters [10], whereas decoding by sound is the ability to pronounce a printed list of phonically regular pseudowords [11].

Sight spelling is the ability to spell the irregular elements of words. The letter strings in those words do not

conform to the most commonly applied spelling rules. In contrast, sound spelling is the ability to spell phonically regular nonsense words or to complete words from which phonically regular parts have been omitted [12].

There are many differences between Arabic and English. This gives the Arabic language its own characteristics and, in turn, its own psycholinguistics. There are huge differences between Arabic and English phonology [13]. In terms of vocabulary, only a minimal number of words in English are borrowed from Arabic. However, many technical words (e.g. computer, radar, helicopter, and television) that are used in the Arabic language have been originally borrowed from the English language. In addition, the acquisition of vocabulary is different in native Arabic-speaking children as compared with their English-speaking peers. Moreover, the grammatical structure of Arabic is very different from that of English. The basis of the Arabic language is the three-consonant root. All verb forms, nouns, adjectives, etc. are formed by placing these three-root consonants into fixed vowel patterns, modified, in some cases, by simple prefixes and suffixes [14]. Moreover, Arabic orthography (writing skills) is a cursive system, running from right to left, and only consonants and long vowels are written [15].

Some psycholinguistic assessment tools have been designed and published, most of which aim at evaluating psycholinguistic skills in English-speaking children. Few have been carried out on the Arabic language [16]. However, further investigations in this area in relation to the Arabic language are still required particularly after the changes that have been made in psycholinguistics definitions, components, and means of assessment, for example, the modifications and changes that have been added to the Illinois Test of Psycholinguistic Abilities, one of the most important tools that has been used to evaluate psycholinguistic abilities in English-speaking children for many years [5].

This work aimed at designing and applying an Arabic Psycholinguistic Screening Tool on a group of native Egyptian students aged 7 through 9, 11 years old (primary grade 1 through primary grade 4) and analyzing the results obtained in order to attain a better understanding of psycholinguistic skills in the studied age range and preliminarily study the constituent items of the tool.

Patients and methods

The sample in this study included 45 healthy native Arabic-speaking Egyptian children: 25 boys and 20 girls. Children were divided into groups as follows: group I (from 7 to 7; 11 years old), group II (from 8 to 8; 11 years old), and group III (from 9 to 9; 11 years old). The participants were attending regular classes in schools following the Egyptian National curriculum, where the language of instruction is Arabic. They were enrolled in primary grade 1 through primary grade 4. They were randomly selected from a cluster of children reported to be subjectively free from any hearing difficulties, delayed

language development, medical problems, and intellectual, social, psychological, psychiatric, or serious academic difficulties.

Before the onset of a study, consent was obtained from parents as well as the school. All participants were then subjected to history taking, and interviews of parents and teachers were conducted. Afterwards, psycholinguistic abilities were evaluated using the Arabic Psycholinguistic Screening Tool (Appendix 1).

For each skill, the student under study obtained a score of 0 or 1 depending on his ability to respond correctly to the introduced item. Thereafter, the scores obtained for each skill were summed up to obtain the raw score for each subtest.

Statistical studies

Data were coded. Thereafter, an IBM compatible PC (International Business Machine Corp. Armonk, New York, USA) was used to store and analyze data. Afterwards, data were thoroughly checked to exclude the existence of any outliers or data entry errors in order to delimit any possible confounding effects they might have on the results obtained. Calculations were carried out using statistical software packages, namely, Statistical Package for Social Science (SPSS). Data were then tabulated and statistically analyzed as follows.

Descriptive statistics

For each group under study, the following were obtained for each subtest involved in the study: arithmetic mean scores (as a measure of central tendency), SD, minimum, and maximum scores (from which the range, the difference between the smallest and the largest observation, was deduced and was used as a measure of dispersion for the obtained scores), in addition to the upper and lower bounds (confidence limits) at a 95% confidence interval (Table 1).

Comparative studies

One-way analysis of variance was used to compare the means obtained by all groups for all the subtests under study (Table 2). Analysis of variance was followed by the post-hoc Tukey test to determine which group, of the compared groups, obtained higher values (Table 3). Results were considered nonsignificant at a *P*-value of more than 0.05 and significant at a *P*-value of less than 0.05.

Correlation studies

Correlation studies were carried out to determine whether the studied parameters (variables) were related to one another or not. The correlation between variables was assessed using the Pearson correlation test. This test detects whether the changes in one variable are accompanied by a corresponding change in the other variable. A significant correlation may be positive, indicating that the change in the two variables is in the same direction, or negative, indicating that the change in the two variables is in the opposite direction. When *r* is close to 0, it means that

there is a weak relationship between the variables tested and when it is close to 1, it means that there is a strong relationship between the tested variables.

Reliability studies

For reliability studies, weighted mean scores were used in order to avoid any bias that could be produced secondary to the unequal number of items constituting each subtest. Reliability studies used included Cronbach's α , Spearman–Brown coefficient, and Guttman's split-half coefficient (Table 4). In addition, correlation between various subtests was also studied as a measure of the internal consistency of the test (Table 5).

Validity studies

- (1) Correlation between tested parameters and age of the participants (Table 6) as an indicator of construct validity (the construct/theory that psycholinguistic skills, like any other developmental skill, are expected to develop with age and thus scores obtained should be positively correlated with age).
- (2) Correlation between various subtests involved in the study (intercorrelation study) (Table 5) as a measure of convergent validity (convergent validity refers to the degree to which a measure is correlated with other measures that it is theoretically predicted to correlate with).
- (3) Content validity: this is a nonstatistical type of validity that involves a systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured [17].

Discussion

This work aimed at designing an Arabic psycholinguistic Screening Tool and testing it on a group of typically developing Egyptian children aged 7 through 9, 11 years old (primary grade 1 through primary grade 4) considering the importance of learning potential and foundations in these early school years for building future academic achievement.

The development of this screening tool was based on the theoretical information gathered and on the results of research and critique that were previously carried out on psycholinguistic screening and assessment tools taking into consideration the crucial modifications required in order to make the tool applicable to Arabic-speaking children as regards their community, culture, and the unique features of their language across all linguistic areas: semantics, syntax, morphology, phonology, and orthography.

Psycholinguistic skills sampled using this screening tool are well documented in the literature. They include oral similarity/analogy, syntactic/morphological closure, proper word and nonsense word repetition [5], phonological deletion and phonological rhyming, sight decoding, decoding by sound [11], and sound spelling [12].

Psycholinguistic skills may be directly related to the construct being measured or the linguistic skills that

Table 1 Results of descriptive statistical studies for all groups: mean values, SD, confidence limits at 95% confidence interval, and minimum and maximum values for each of the tested parameters

Subtests	Groups	Number of children	Mean	SD	95% Confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
Oral similarity	Group I	15	17	5	15	20	7	23
	Group II	15	19	3	17	20	14	24
	Group III	15	22	2	21	23	18	24
Morphological closure	Group I	15	22	6	19	26	8	28
	Group II	15	24	3	22	26	17	28
	Group III	15	27	2	26	28	21	28
Proper word repetition	Group I	15	3	1	2	3	1	4
	Group II	15	3	1	2	4	1	5
	Group III	15	4	1	3	4	2	6
Nonsense word repetition	Group I	15	1	1	0	1	0	3
	Group II	15	1	1	1	2	0	3
	Group III	15	1	1	1	2	0	3
Phonological deletion	Group I	15	15	7	11	18	0	20
	Group II	15	19	2	18	20	14	20
	Group III	15	19	1	19	20	17	20
Phonological rhyming awareness	Group I	15	4	2	3	5	1	7
	Group II	15	5	2	4	6	2	7
	Group III	15	5	1	5	6	4	7
Phonological rhyming production	Group I	15	4	3	3	6	0	8
	Group II	15	6	3	4	7	0	8
	Group III	15	6	2	5	8	0	8
Spoken vocabulary	Group I	15	17	5	15	20	11	23
	Group II	15	19	3	18	21	13	23
	Group III	15	23	1	23	24	20	25
Written vocabulary	Group I	15	11	6	8	15	1	20
	Group II	15	17	5	14	20	10	24
	Group III	15	22	3	21	24	14	25
Sequencing events	Group I	15	5	4	2	7	0	11
	Group II	15	11	4	8	13	2	17
	Group III	15	14	4	11	16	3	17
Sight decoding	Group I	15	15	6	11	18	0	24
	Group II	15	21	3	20	23	16	25
	Group III	15	22	3	21	24	17	25
Sound decoding	Group I	15	16	9	11	21	0	25
	Group II	15	21	5	18	23	9	25
	Group III	15	24	1	24	25	23	25
Sight spelling	Group I	15	18	6	15	21	0	24
	Group II	15	21	2	20	22	16	24
	Group III	15	21	3	20	23	17	25
Sound spelling	Group I	15	16	6	13	19	0	22
	Group II	15	18	6	15	21	0	25
	Group III	15	21	3	19	23	14	24

Table 2 Comparison between the scores obtained for all groups using the analysis of variance test

Test	F	Significant	Significant or not
Oral similarity	7.268	0.002	Significant
Morphological closure	3.928	0.027	Significant
Proper word repetition	4.073	0.024	Significant
Nonsense word repetition	1.099	0.343	Nonsignificant
Phonological deletion	6.142	0.005	Significant
Phonological rhyming awareness	2.667	0.081	Nonsignificant
Phonological rhyming production	1.907	0.161	Nonsignificant
Spoken vocabulary	14.940	0.000	Significant
Written vocabulary	20.272	0.000	Significant
Sequencing of events	18.719	0.000	Significant
Sight decoding	13.656	0.000	Significant
Sound decoding	6.882	0.003	Significant
Sight spelling	2.828	0.070	Nonsignificant
Sound spelling	3.739	0.032	Significant

contribute to the performance of a specific task. The process of learning includes the ability to access semantic knowledge, as in an oral similarity subtest. Participation in the involved tasks requires the ability to access

appropriate syntactic rules and use morphological rules as in the morphological closure subtest, adequate phonological awareness as in the phonological rhyming, production and deletion subtests, efficient auditory memory skills as well as auditory sequential memory skills as in word repetition tasks, vocabulary as in the written and spoken vocabulary tasks, identification and appropriate use of pertinent information as in sequencing events as well as reading and spelling skills as in the decoding and spelling tasks, respectively. In addition to these tasks, which are directly related to the skills measured, participation in the constituent tasks indirectly necessitates appropriate activity level, attention, cooperation, and ability to participate in the required tasks. All these skills are essential for studying and following classroom instructions.

After designing the Arabic Screening Tool and applying it on the intended age groups, the results were statistically analyzed. Among the studied statistical parameters were the confidence interval and limits. For consistency, obtained data were reported using a cut-off value, often

Table 3 Comparison between the scores obtained for all groups using the post-hoc Tukey test

Dependent variable	Groups	Differences between the means obtained by the groups under study	The group that obtained the greater value
Oral similarity	I and II	-1.26667	2
	I and III	-4.46667*	3
	II and III	-3.20000*	3
Morphological closure	I and II	-1.73333	2
	I and III	-4.06667*	3
	II and III	-2.33333	3
Proper word repetition	I and II	-0.13333	2
	I and III	-1.00000*	3
	II and III	-0.86667	3
Nonsense word repetition	I and II	-0.06667	2
	I and III	-0.46667	3
	II and III	-0.40000	3
Phonological deletion	I and II	-4.20000*	2
	I and III	-4.60000*	3
	II and III	-0.40000	3
Phonological rhyming awareness	I and II	-0.80000	2
	I and III	-1.33333	3
	II and III	-0.53333	3
Phonological rhyming production	I and II	-1.33333	2
	I and III	-1.86667	3
	II and III	-0.53333	3
Spoken vocabulary	I and II	-2.06667	2
	I and III	-6.33333*	3
	II and III	-4.26667*	3
Written vocabulary	I and II	-5.66667*	2
	I and III	-	3
	II and III	10.80000*	3
Sequencing of events	I and II	-5.13333*	2
	I and III	-6.06667*	3
	II and III	-9.00000*	3
Sight decoding	I and II	-2.93333	3
	I and III	-6.53333*	2
	II and III	-7.60000*	3
Sound decoding	I and II	-1.06667	3
	I and III	-4.93333	2
	II and III	-8.06667*	3
Sight spelling	I and II	-3.13333	3
	I and III	-2.73333	2
	II and III	-2.93333	3
Sound spelling	I and II	-0.20000	3
	I and III	-1.53333	2
	II and III	-4.93333*	3
		-3.40000	3

*The mean difference is significant at the 0.05.

Table 4 Reliability studies

	Value
Cronbach's α	
Part 1	0.867
Part 2	0.822
Spearman-Brown coefficient	
Equal length	0.948
Unequal length	0.948
Guttman's split-half coefficient	0.607
Cronbach's α	0.857
Cronbach's α based on standardized items	0.948

Values close to 0 = a weak relationship between the tested variables.
 Values close to 1 = a strong relationship between the tested variables.

less than -2 and more than +2 Z-scores. The rationale for using this statistical method was to obtain a more accurate view of the 'normal' range of the parameters

measured for each of the age groups studied. In other words, confidence interval was used to determine the range of the values that would be expected to be obtained by the normal population. A wide interval indicated that the estimate was a less precise estimate whereas a narrow one indicated a more precise one. Thus, the confidence limits obtained for spoken vocabulary, for example, by Group III [23,24] reflected a more precise estimate of the normal population mean for this age range than the limits obtained for Group II [18-21] and Group I [15-20].

Comparative statistical analyses were also included in the study; the lowest scores for the oral similarity subtest were obtained by group I, whereas the highest scores were obtained by group III. This shows that the child's analogical skills, like other developmental skills, are expected to develop as the child grows. This could be attributed not only to an increase in the vocabulary the child is expected to acquire but also to the development of verbal reasoning and cognitive skills as a whole.v

In this study, the lowest scores for morphological closure subtest were obtained by group I. However, the highest scores were obtained by group III. However, it should be noted that despite the fact that most of the basic grammatical/syntactic rules are expected to be fully acquired by the age of four and half, some of the children in the study seemed to have difficulties with using some of the grammatical rules, although syntax did not informally seem to be an area of concern. This could be attributed to the fact that the difficulties exhibited by these children were due to their inability to understand what was actually required from them rather than being related to a true syntactic difficulty. Prompts were required to help some children properly respond, a fact that should be taken into consideration while applying the screening tool and/or revising its constituent items and scores.

Comparison between the results obtained by the different groups under study for the nonsense word repetition subtest revealed nonsignificant differences between all the groups under study as opposed to the significant differences obtained between the groups for the other subtests. This could be partially related to the innate difficulty of the task in addition to the small size of the sample studied. Thus, it is essential to study the test on a larger sample before considering it as a standardized valid test.

On comparing the performance of the children under study as regards their ability to repeat meaningful words versus nonsense words, participants obtained better results on tasks with meaningful verbal sequences (proper word repetition) than they did on those with nonsense word repetitions. These results should be taken into account while carrying out similar future studies on auditory-verbal sequential abilities in school-aged children as some of the children may be able to repeat the introduced words using some strategies such as chunking/phonemic similarity instead of solely relying on an efficient phonological processing foundation.

Table 5 Intercorrelation studies between all subtests in the study

Subtests	Morphological closure	Proper word repetition	Phonological deletion	Phonological rhyming awareness	Spoken vocabulary	Written vocabulary	Sound decoding
Oral similarity							
Pearson's correlation	0.896	0.555	0.519	0.509	0.797	0.633	0.566
Significant (two-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Proper word repetition	Phonological deletion	Spoken vocabulary	Written vocabulary	Sound decoding		
Morphological closure							
Pearson's correlation	0.501	0.526	0.730	0.621	0.560		
Significant (two-tailed)	0.000	0.000	0.000	0.000	0.000		
	Written vocabulary	Sequencing of events	Sight decoding	Sound spelling			
Spoken vocabulary							
Pearson's correlation	0.732	0.535	0.586	0.620			
Significant (two-tailed)	0.000	0.000	0.000	0.000			
	Written vocabulary	Sight decoding	Sound decoding				
Phonological deletion							
Pearson's correlation	0.528	0.523	0.568				
Significant (two-tailed)	0.000	0.000	0.000				
	Sight decoding	Sound decoding	Sound spelling				
Sequencing of events							
Pearson's correlation	0.690	0.570	0.540				
Significant (two-tailed)	0.000	0.000	0.000				
	Sound decoding	Sight spelling	Sound spelling				
Sight decoding							
Pearson's correlation	0.777	0.743	0.563				
Significant (two-tailed)	0.000	0.000	0.000				
	Phonological rhyming	Spoken vocabulary					
Phonological rhyming awareness							
Pearson's correlation	0.587	0.538					
Significant (two-tailed)	0.000	0.000					
	Spoken vocabulary	Written vocabulary					
Phonological rhyming production							
Pearson's correlation	0.524	0.573					
Significant (two-tailed)	0.000	0.000					
	Sequencing of events	Sight decoding					
Written vocabulary							
Pearson's correlation	0.653	0.565					
Significant (two-tailed)	0.000	0.000					
	Sight spelling	Sound spelling					
Sound decoding							
Pearson's correlation	0.645	0.717					
Significant (two-tailed)	0.000	0.000					
	Sound spelling						
Sight spelling							
Pearson's correlation	0.606						
Significant (two-tailed)	0.000						

Correlation is significant at the 0.05.

There is now a growing consensus that the relationship between phonological skills and reading development is a reciprocal one. Phonological skills contribute to successful reading and reading development also contributes to successful phonological skills [18]. In this study, phonological deletion skills were studied and the results revealed an obvious discrepancy between the groups under study. This could be related to the fact that in the youngest group, children solely depend on their phonological loop of the working memory to deal with this task. As children start to learn how to read in early preschool years, they gain an additional skill in conjunction to their

phonological loop: what is known as symbol imagery. Using these two strategies together can aid in promoting and highly enhancing phonological deletion skills in early readers.

Phonological rhyming skills are crucial for effective learning skills. In the current study, analysis of the results obtained for phonological rhyming awareness and phonological rhyming production subtests showed that the lowest scores were obtained by group I and the highest scores were obtained by groups III. However, the differences between groups were found to be statistically

Table 6 Correlation between the scores obtained for all subtests in the study, age of the participants involved in the study, and overall score

	Age in months	Overall score
Oral similarity		
Pearson's correlation	0.462**	0.774**
Significant (two-tailed)	0.001	0.000
Morphological closure		
Pearson's correlation	0.348*	0.751**
Significant (two-tailed)	0.019	0.000
Proper word repetition		
Pearson's correlation	0.394**	0.483**
Significant (two-tailed)	0.007	0.001
Nonsense word repetition		
Pearson's correlation	0.203	0.283
Significant (two-tailed)	0.181	0.059
Phonological deletion		
Pearson's correlation	0.322*	0.685**
Significant (two-tailed)	0.031	0.000
Phonological rhyming awareness		
Pearson's correlation	0.248	0.691**
Significant (two-tailed)	0.100	0.000
Phonological rhyming production		
Pearson's correlation	0.253	0.704**
Significant (two-tailed)	0.093	0.000
Spoken vocabulary subtest		
Pearson's correlation	0.600**	0.830**
Significant (two-tailed)	0.000	0.000
Written vocabulary		
Pearson's correlation	0.689**	0.792**
Significant (two-tailed)	0.000	0.000
Sequencing of events		
Pearson's correlation	0.662**	0.747**
Significant (two-tailed)	0.000	0.000
Sight decoding		
Pearson's correlation	0.510**	0.812**
Significant (two-tailed)	0.000	0.000
Sound decoding		
Pearson's correlation	0.480**	0.786**
Significant (two-tailed)	0.001	0.000
Sight spelling		
Pearson's correlation	0.286	0.612**
Significant (two-tailed)	0.057	0.000
Sound spelling		
Pearson's correlation	0.391**	0.713**
Significant (two-tailed)	0.008	0.000
Age in months		
Pearson's correlation		0.604**
Significant (two-tailed)		0.000
Overall score		
Pearson's correlation	0.604**	
Significant (two-tailed)	0.000	

*Correlation is significant at the 0.05 (two-tailed).

**Correlation is significant at the 0.01 (two-tailed).

nonsignificant. This could be related to the nature of the Arabic national curriculum, which is devoid of activities that focus on practicing and enhancing these skills.

As for written vocabulary, some students under study seemed to be more specific in using peculiar creative referents while filling in the blanks, whereas others used more general words and/or words from well-known memorized phrases. Nevertheless, they both obtained a score of 1. This did not allow sufficient grading according to the children's performance, a fact that should be taken into consideration when carrying out further studies.

Children's sequencing skills are expected to emerge and develop with age. This can be attributed not only to vocabulary enrichment, which is expected to occur as the child grows, but also to the development of reading skills and understanding as a whole.

For some children, sight and sound decoding skills seemed to be related to the word being presented in an isolated form. It is expected that some of these children would have been able to overcome such difficulties if the words had been presented within a text where the children can depend on other cues such as syntactic and auditory closure to remember the correct sequence of words, an assumption that should be taken into consideration while designing similar Arabic decoding subtests.

In this study, sight spelling and sound spelling subtests were used to test the ability of the child to spell words by sight or by decoded segmentation, respectively. It was obvious that many of these children mainly depended on sight spelling while writing down the dictated words and, thus, they faced major difficulties when sound spelling was introduced and their performance obviously deteriorated.

Significant differences were found between the studied groups for sound spelling. As for sight spelling, non-significant differences were found between the groups under study. This could be related to the inherent difficulty of the introduced item or the lack of exposure to tasks that would enhance such skills in the national Arabic curriculum applied in Egypt.

From the above findings, it is obvious that the differences between all groups were statistically significant for oral similarity, morphological closure, proper word and nonsense word repetition, phonological deletion, phonological rhyming awareness and production, spoken and written vocabulary, sequencing events, sight and sound decoding as well as sight and sound spelling. On carrying out the post-hoc Tukey test, the results revealed higher values for the older age group with regard to all subtests measured. This implies that the older the students are, the better their performance is expected to be. However, this was not observed in nonsense word repetition, phonological rhyming awareness, phonological rhyming production, and sight spelling subtests. This might be related to the fact that these tasks are rarely practiced in the national Arabic curriculum during early school years. Therefore, the content and difficulty level of these subtests need to be revised.

Reliability refers to the consistency of a set of measurements or of a measuring instrument [19]. For reliability testing, weighted mean scores were used in order to avoid the bias that might develop secondary to the difference in the number of items constituting each subtest. Internal consistency was measured by studying the correlation between different subtests in order to determine whether they all measure the same general construct that they are proposed to measure, namely, psycholinguistics.

The constituent items of any reliable tool should be highly correlated with each other (internally consistent) but still each of them should contribute some unique information as well. Otherwise, the test would be considered a redundant one. To test the internal consistency of the designed tool, split-half reliability and Cronbach's α were used. Split-half reliability was

determined by showing that the response to the items on one part of the test was correlated with the response given to the items on the other part of the test. However, Cronbach's α was calculated from the correlations between different items.

Cronbach's α generally increases as the intercorrelations among test items increase, and is thus known as an internal consistency and reliability. Intercorrelations among test items are maximized when all items measure the same construct [20–22]. Cronbach's α is widely used to indirectly indicate the degree to which a set of items measures different substantive areas within a single construct [23,24]. The values obtained for Cronbach's α in the current study were between 0.8 and 0.9, indicating good internal consistency, and also reflected nonredundancy.

Correlation analysis was used to measure the degree of associations between variables. A significant positive correlation was found between oral similarity and morphological closure. This might be related to the nature of the tasks involved in these two subtests and the skills needed to perform these tasks. Both require intact inferential skills, the ability to draw comparisons between the two presented items, the ability to retrieve required information and, accordingly, the ability to respond in a relevant manner.

A significant positive correlation was also found between oral similarity and spoken vocabulary. Oral similarity tasks require the ability to retrieve words from memory. For words to be retrieved, they have to be available in one's lexicon.

Spoken vocabulary and written vocabulary were also found to be positively correlated with each other, suggesting a relationship between one's oral and written lexicons. The positive correlation obtained between the ability to sequence events and sight decoding could be partially attributed to the temporal processing skills that both tasks require in order to be efficiently carried out. Sight decoding was also found to be positively correlated with sound decoding and each of them was positively correlated with sight spelling and sound spelling, reflecting a relationship between reading and spelling skills.

Evidence for content validity is based on the degree to which the items adequately represent and relate to the construct being measured. The content should reflect the concepts being measured and relate to the proposed application and interpretation of the test. Content validity of the test was examined by reviewing all the tasks in the study and comparing them with those available in the literature [5].

The content of subtests used with children must appropriately reflect developmental aspects of the concepts being measured. Inappropriate content (both construct related and social appropriateness), item rewording, or item construction (administration rules and wording of instructions) may confound the interpretation and usefulness of test scores. All these factors were taken into consideration while revising the content of the designed tool in order to exclude the existence of any possible bias.

The goal of content revision in the current study was also to ensure that the tasks involved adequately sample the psycholinguistic domains, with particular attention to the age group involved in the study. Comprehensiveness, level of vocabulary used, level of abstract versus concreteness, level of ambiguity, and the syntactic structure of the items involved in the test were also taken into consideration while reviewing its content.

Patterns of subtest intercorrelations reflect the degree to which the subtests are related. Subtests that measure similar abilities are expected to have moderate-to-high correlations. Significant intercorrelations obtained between most of the subtest scores, for example, between oral similarity and vocabulary reflected convergent validity of the Psycholinguistic Screening Tool.

Whereas convergent validity refers to the degree to which the test items are intercorrelated, construct validity is the extent to which the test measures a theoretical construct or trait. As such, it related to the degree to which the underlying traits of the test can be identified and the extent to which these traits reflect the theoretical model on which the test is based. Three basic concepts were chosen and studied to serve as bases for the construct validity of the Arabic Psycholinguistic Screening Tool. These included the following: (a) studying the correlation between age and the scores obtained (Table 6) because linguistic abilities are developmental in nature and thus are expected to develop with age, (b) because the tool was designed to measure various aspects of language, most of its items should correlate significantly with each other. This was proven by the correlation studies carried out between various subtest scores (Table 5), and (c) because the subtests measure psycholinguistic scores, the scores obtained for each subtest should be highly correlated with the total psycholinguistic score obtained. This was proven by the correlation studies carried out between the total score and the subtest scores, Table 6.

Conclusion and recommendations

- (1) The results of the current study prove the internal consistency and validity of the Arabic Psycholinguistic Screening Tool for children aged 7 through 9; 11 years old. However, further studies including inter-rater and intra-rater reliability measures as well as predictive validity need to be carried out on a larger group of children and on a wider scale. This will ensure internal consistency of the test.
- (2) On using any psycholinguistic screening tool, it is essential to qualitatively analyze the child's performance rather than merely depend on the numerical results and quantitative analysis.
- (3) Studies using this screening tool should be carried out on a group of children with learning disabilities to examine the diagnostic sensitivity of this screening tool in diagnosing children who have or are at risk of developing learning disability (in conjunction with cognitive and educational assessments).

(4) The nonsense word repetition, phonological rhyming awareness, phonological rhyming production, and sight spelling subtests and their constituent items should be revised taking into consideration the Arabic educational curriculum applied in Egyptian schools.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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Appendix 1

Psycholinguistic tasks involved in the Arabic Psycholinguistic Screening Tool

	Aim	Task	Example	Raw score
Oral similarity	To test the child's verbal reasoning and expressive semantics.	Each child was exposed to 25 sets; each was composed of two short sentences. The first one was a complete sentence whereas the second one was incomplete. The student was asked to fill in the second sentence with a word that would complete the similarity and properly fit in.	الفيل كبير؛ والنملة... The child responds صغيرة	Out of 25
Morphological closure	To test the child's ability to appropriately use common morphological forms (i.e. word structure) in his spoken language.	Each child was exposed to 28 sets, each of which was composed of two short sentences. The first was a complete sentence whereas the second one was incomplete. The student was asked to fill in the second sentence with a word that would complete the sentence with the correct morphological structural form.	سرير واحد؛ ولو اثنين يبقوا The child responds سريرين	Out of 28
Proper word repetition	To test the child's auditory sequential memory	Each child was asked to separately repeat eight sets each composed of proper words that gradually increased in number and length.	أكرم- وفاء- سحر	Out of 8
Nonsense word repetition	To test the child's auditory sequential memory, listening skills, and word imitation skills (verbal imitation skills) in his spoken language without relying on auditory closure strategies.	Each child was asked to separately repeat eight sets each composed of a number of nonsense words that increased in length.	سلطب - نقص - حافن مشاعر without the /m/	Out of 8
Phonological deletion	To test the child's phonology and ability to delete sounds from words in his spoken language as a measurable indicator of his reading performance.	A word was introduced to each child and he was asked to delete a certain specified phoneme named by the assessor	شاعر The child responds شاعر	Out of 20
Phonological rhyming awareness	To evaluate the child's ability to identify the difference between words in relation to rhyming	Seven sets, each composed of strings of four words, three of that had the same rhymes, with the fourth having a different rhyme, were introduced to each child and he was asked to choose the one that does not rhyme with the other three words.	نيل-تاب-خاب- عاب	Out of 7

Phonological rhyming production	To test the child's ability to hear and detect the rhyming of words as well as orally produce a rhymed word.	The child was given a certain word and was asked to mention a word that rhymed with the one given	فار The child responds دار	Out of 8
Spoken vocabulary	To test the child's recognition and use of vocabulary while listening and speaking, and to assess his semantics and ability to identify relationships between words.	An attribute was introduced and the child was asked to think of a word that possesses that attribute.	ذيل The child responds e.g.	Out of 25
Written vocabulary	To evaluate the child's ability to read, comprehend, and write a meaningful sentence.	An adjective was introduced and the child was asked to write a relevant noun	قطعة تقيل----- The child responds e.g. الحديد	Out of 25
Sequencing of events	To test the child's ability to construct a meaning from a printed material, comprehend the meaning of sentences, and create a coherent cognitive framework based on sentences (as these skills are essential for written language development).	18 sets graded in length and complexity were introduced to each child; each of these was composed of a misarranged series of sentences and the child was asked to arrange the sentences in a logical manner to form a meaningful passage. The child had to write down his answer.	أ) أنا شربت الماء ب) أنا أحضرت زجاجة الماء ج) أنا فتحت زجاجة الماء The child responds أ) أنا أحضرت زجاجة الماء	Out of 18
Sight decoding	To test the child's ability to pronounce exceptional words (i.e. those that contain unwritten sounds or silent letters).	25 words were introduced; all contained unwritten sounds or silent letters were introduced to the child. The child was then asked to read the words, each at a time.	ب) أنا فتحت زجاجة الماء ج) أنا أشرب الماء الشمس, نور	Out of 2
Sound decoding	To evaluate the child's ability to pronounce a printed list of phonically regular pseudowords (as a means of tapping his knowledge of letter-sound correspondence).	25 sets were introduced to the child. For each set, the child was asked to pronounce a printed list of phonically regular pseudowords.	عو - دان	Out of 25
Sight spelling	To test the child's ability to spell irregular elements of words.	25 words were introduced (each had a silent letter or an unwritten sound) and the child had to write down each word.	السيارة	Out of 25
Sound spelling	To assess the child's ability to spell phonically regular nonsense words.	A list of nonsense words was dictated to the child and he was asked to write them down.	ليار - حاب	Out of 25