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The contribution of phonological awareness and naming speed to reading vowelized and unvowelized texts in Arabic

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ABSTRACT

The aim of this study is to assess the contribution of and phonological awareness and naming speed abilities to reading in the Arabic language. For this purpose, 117 third and fifth grade Arabic-speaking children with intact verbal abilities were given measures of phonological awareness and naming speed, as well as reading measures of vowelized and unvowelized texts. The results revealed a modest correlation between phonological awareness and naming speed (NS) measures. Also, as predicted, a significant relationship was found between phonological awareness measures and reading accuracy; and between naming speed measures and fluency. Following, Hierarchal regression analyses revealed that, phonological awareness measures contributed significantly to variance in reading accuracy, and naming speed measures contributed a unique variance in reading fluency. Further analysis revealed that naming speed measures explain more variance in fluency and explained more variance in third grade than in fifth grade while phonological awareness measures explained more variance in fifth grade than in third grade. These results reveal that both abilities are key components in reading acquisition in Arabic, and that their relative contribution to reading not only depends on the orthographic transparency, but to other features as well.

Indexing terms/Keywords

Phonological Awareness; naming speed; reading; Arabic; diglossia

Academic Discipline And Sub-Disciplines

Education; Psychology.

INTRODUCTION

Recent studies led the authors to suggest that much is unknown about the processes underlying efficient extraction of meaning from reading ([1]. Katzir and her colleagues [1] examined the multiple pathways of dysfluency at the word and connected-text level and found differences among the double deficit (DD) hypothesis subtypes at both reading levels. The first goal of this study is to examine how independent is naming speed ability from phonological awareness ability in the context of text reading level. This issue is of great importance because adopting one or the other view dictates many aspects of the diagnosis and treatment in a Arabic, language that has not been investigated before in this context. If current practice places naming speed problems as part of phonological deficit, then no direct assessment or intervention will be aimed for this cognitive ability, if, however, phonological and naming speed processes represent two independent sources of breakdown, then there are critical implications for diagnosis, sub-typing efforts, and most importantly intervention [2].

Second, this investigation in Arabic language is of great importance for diagnosis, sub-typing efforts, and, most importantly, intervention with reading difficulties [2].

Although there is a significant body of evidence linking NS and reading ability, the studies report inconsistent results. These inconsistencies can be attributed to many factors, which may be attributed to three factors:

1. The nature of the naming task (discrete or sequential) and the type of stimuli (letters, digits, colors and simple objects). This factor is important because different types of stimuli require different cognitive abilities, and understanding the role the task's format plays in the relationship to reading strengths, and the relationship between NS and reading in general. Different studies investigated different types of naming tasks, leading to different results and confusion in the literature.

2. Which aspect of reading is being investigated, accuracy or fluency. The definition of reading has undergone major changes. While dyslexics were once identified only by measures of accuracy, today the definition includes fluency. The nature of the reading task (i.e., single word or connected text) has also contributed to the inconsistencies of the relationship.

3. The effect of the orthographic depth of the language in which the study was carried out.

Kail and Hall [3] claimed that the development of a general speed factor among normal readers explains the changes in NS. They examined 144 children, ages 8-13, using general processing time measures, naming measures, and various reading measures. They found systematic increases in speed of processing, NS, and reading ability with age. Their results led to the following model: changes in speed of processing lead to changes in NS, which in turn leads to changes in word recognition, which then explains changes in reading comprehension. According to these authors, NS is influenced by a general processing speed, which develops with age and is not the direct result of an increase in age or experience [3].

The question remains as to why alphanumeric and non-alphanumeric naming stimuli have different predictive powers. Savage and Frederickson [4] suggested that picture naming, for example, may tap attention resources in a way that digit naming does not. This may be especially true in older children where letter and number recall have become automatized.

While this is an important issue, the aim of this study is to determine the contributions of the more basic processes of NS and phonological awareness to reading ability. This requires a look at the less researched relationship between NS and reading fluency.

Reading fluency

In recent years, the issue of fluency has evoked interest among researchers dealing with reading and dyslexia, resulting in the inclusion of the term fluency in the current definitions of the dyslexia phenomenon as a separate factor from accuracy [5]. Nevertheless, there is still no consensus on the definition of fluency as related to reading. Nor is there agreement about whether fluency is a dependent variable and as such represents a diagnostic measure for the quality of reading, or whether it is an independent variable that affects the quality of reading.

Several hypotheses have been suggested to explain decreased reading rate based on the assumption that word reading rate is a dependent variable. Greene et al. [6] proposed that the level of word reading accuracy, the reader's age, acquaintance with reading skills, and development of word reading automaticity all account for decreased reading rate. Perfetti [7] claimed that slow word recognition interferes with reader's ability to retain large units of text in the working memory (bottleneck theory), which prevents reading from being efficient. The basic view among researchers positing reading rate as a dependent factor is based on the claim that reading is a linguistic process. As such, its effectiveness is based on the level of acquisition, mastering and performance of its sub-lexical components which are letters, graphemes and phonemes, multi-letter units, words, pseudowords, and connected text.

Additional explanations of reading difficulties were offered in the 1990s following technological advances in in-depth observation of cognitive processes. Theories such as the double deficit hypothesis [2], the systems analysis approach [8], and speed of information processing [9] were suggested as explanations for the fluency and dysfluency in reading [10]. These theories addressed fluency as an independent source of reading skill. For the purpose of this study, the definition of fluency offered by Wolf and Katzir-Cohen [11], which integrates a developmental and componential view, will be adopted: "….achieving reading fluency involves the successful integration of information from the phonological, orthographic, semantic, syntactic, and morphological processes" [12].

The nature of Arabic

The classical definition of diglossia, proposed by Ferguson [13], is that it is a stable linguistic state that includes different spoken dialects and a totally different literary language, which is usually grammatically complicated, as distinct from the different spoken dialects, and includes a respectable written literature. This literary version is studied in school and is not acquired naturally without formal learning. It is the language for formal communication and is not the language of day-to-day conversation. A diglossic context has two features: a differentiation between the written and the oral modes; and a rigid socio-functional complementarities of two separate sets of functions performed by two markedly distinct, though linguistically related, codes.

Arabic is a typical case of diglossia. According to Saiegh-Haddad [14], Modern Standard Arabic (MSA) , so-called fuṣḥa is the language used throughout the Arabic speaking world for writing and some other formal functions , such as speeches and religious sermons, while the Spoken Arabic Vernacular (SAV) is the language used for everyday conversation. Though SAVs are all linguistically related to MSA, they are distinct and structurally markedly distant from it. Ayari [15] & Abu-Rabia [16] agree with the above definition of diglossia and the linguistic distance described by Saiegh-Haddad [14]. Ayari [15] adds that this diglossic situation of the Arab world hinders children's acquisition of reading in Arabic. They encounter difficulties already in first grade when they are required to study literary Arabic, which is a totally different language from spoken Arabic. In addition, he notes, unfortunately preschool children are not exposed to literary Arabic because there is near consensus in the Arab world that literary Arabic is difficult for them and they should not be exposed to it before first grade. Parents, teachers and educators share this belief. Consequently, these children encounter literary Arabic in first grade almost as a second language. According to Ayari [15], this means that children are required to cope simultaneously with reading and writing in a second language (literary Arabic). He argues for early exposure of these children to literary Arabic, in the preschool period, as the proper strategy to enhance their Arabic-reading acquisition.

Ibrahim [17] reports findings that provide cognitive basis of diglossia in Arabic. In his study, repetition priming effects were compared within spoken Arabic (SA), as well as with the effects found when primes were in either literary Arabic (LA) or Hebrew. The results show that lexical decisions for words in SA were not influenced by previous presentations of translation equivalents in LA. Findings from an earlier study by this author on semantic priming effects [18] suggest that the status of LA is similar to that of Hebrew and is consistent with the typical organization of second language (L2) in a separate lexicon. Thus, learning LA appears to be, in some respects, more like learning a second language than like learning the formal register of one's native language (p. 93).

In addition to its diglossic nature, two other features play essential roles in assessing reading and examining the predicative power of different processes of the Arabic language: morphology and orthography.

The morphology of Arabic is based on the "root and pattern" principle that characterizes Semitic languages. Roots are composed of three or four consonants, although some roots consist of five or two consonants [19; 20; 21]. The root represents the basic sense of the word, and every pattern is composed of vowels and additional consonantal letters that impart specific lexical meaning and grammatical and syntactic information. Like other Semitic languages, such as Hebrew, Arabic is characterized by a rich derivational and inflectional morphology [22]. It is a highly agglutinative language (i.e., one word can correspond to a whole English sentence) which results in a highly derivational and dense morphology. Although this can be helpful in communicating the core semantic meaning of the root embedded in various patterns, it demands a lot of unpacking on the part of the reader in order to arrive to the exact meaning of a word in Arabic [23]. In their overview of the developmental dyslexia in the Hebrew language, Share and Leikin [24] claim that morphological knowledge is likely to be a source of individual differences in reading ability because roots are phonologically highly opaque, manifest at the surface level in a variety of syllable forms.

Arabic orthographyconsists of 17 characters, which, when combined with dots placed above or below various letters, make up the 28 letters of its alphabet. Dots are therefore extremely important and differ in number (one, two or three) and position (below or above the letter). The form of a particular letter varies depending on its position in the word, 22 of the 28 letters of the alphabet have four shapes each (word initial, medial, final, and a different grapheme when it follows a non-connecting letter). Moreover, there are two different scripts in Arabic: vowelized and unvowelized. The vowelized script consists of the 28 letters and short-vowel diacritics that are located above, and/or in, and/or below the letters. In this case, there is a predictable sound-symbol correspondence between the letters and their sounds, making Arabic a transparent orthography. In the unvowelized scripts, these short vowels do not accompany the letters and must be deduced by the reader. In most modern written and printed literary Arabic texts, no short vowels signs are given, so the reader must deduce them by relying on context or prior linguistic knowledge: grammar, syntax, and exposure to print [19; 25]. Recognizing the nature of these letters and their diverse writing rules in different positions, and recognizing the different short vowels under, in, and above the letters are critical for readers' word pronunciation, which may demand considerable cognitive attention. Thus, reading a fully vowelized text is likely to be cognitively demanding for a beginning reader, who must simultaneously process many rules in order to extract meaning from print or read out loud accurately [25].

Ibrahim, Eviatar, and Aharon-Peretz [18] investigated the effect of the complexity of Arabic orthography on the process of word identification. Adolescent Arabic speakers who mastered Hebrew as a second language completed oral and visual versions of the Trail Making Test (TMT) in both languages. Performance on the Hebrew and Arabic oral TMT did not differ, but was significantly slower on the Arabic visual TMT. The authors concluded that Arabic speakers process Arabic orthography (first language) slower than Hebrew orthography (second language, and suggested this was due to the complexity of Arabic orthography.

The findings of the above studies on the Arabic language highlight the necessity for research that is sensitive to the nature of Arabic and encompasses the different cognitive skills that are involved in the process of acquiring reading ability. The present study, however, deals with the more basic task of clarifying the roles of NS and phonological processes in an unselected Arabic-speaking sample and their contribution to reading at three different levels.

The literature on this issue in the context of the Arabic language is scarce, and what exists focuses on the word and not the connected-text level. Most research was conducted with the English language, which, unlike the transparent orthography of Arabic, is classified as a deep orthography language.

Objectives and Hypotheses

The first objective of the study is to explore the relationship between phonological awareness and naming speed in early and later stages of reading development in the Arabic language.

The second objective is to explore the degree of association between reading accuracy and rate of vowelized and unvowelized text at the different stages of reading development. The two main questions are:

1. Do Phonological awareness and NS measures will correlate and will these two abilities contribute in different ways to accuracy and fluency.

2. Based on literature from shallow orthographies and recent research in the Arabic language, the question is whether phonological awareness variables will be significantly correlated with accuracy measures and NS measures will correlate with fluency measures.

METHOD

Participants

117 native Arabic speaking children (52 boys and 65 girls) were randomly selected from two public schools in a city in northern Israel: 58 pupils were in third grade (mean age: 8.4 years, SD 4.15 months) and 59 were in fifth grade (mean age: 12.36 years, SD 3.51 months). All of the children came from a middle socio-economic background, were born and resided in the same city, and spoke the same local vernacular.

Materials

Peabody Picture Vocabulary Test (PPVT)

The PPVT, which is considered a proxy measure for verbal IQ (Appendix A) was adapted to Modern Standard Arabic. The test was discontinued after 6 errors on 8 consecutive items. One point is awarded for each correct item.

Rapid automatized naming (RAN)

The test is comprised of two subtests: one for letters and one test for numbers. The test was modeled after Denckla and Rudell [26]. Children were asked to name five letters (س- أ- ض- ج- ث), and five digits (1-5-9-3-7). The letters and the digits were arranged randomly in five rows of ten letters/digits each. A practice session in which the children were asked to name the five letters and digits preceded the timed trial. All the children accurately named all five digits and all five letters. In the actual trial, the children were required to name the letters and digits as quickly as they could. The time it took a child to name all digits and letters was recorded as the child's automatized NS. Two types of letters were included in the list: three phonemes representing SAV: أ، س، ج and two phonemes representing MSA: ث، ض. Two NS ability will be measured: letter naming speed (LNS) and number naming speed (NNS).

Phonological awareness

Three measures of phonological awareness were developed for this study: syllable deletion, phoneme deletion, and phoneme synthesis.

Syllable and phoneme deletion required the participants to repeat a word after deleting a certain syllable/phoneme. The syllables and phonemes to be deleted were from both spoken and written vernacular, in accordance with Saiegh-Haddad's findings [14] of the differential effect of deleting a phoneme/syllable from the spoken or written vernacular. Another consideration was the location of the deleted item (initial, middle or final) which was also found to have an effect on the child's ability to manipulate phonemes [27]. There were six practice items to ensure that the children understood the task, with feedback provided by the examiner. The task itself included 24 test items, each consisting of 3-5 phonemes, 1-3 syllables. The reliability of the syllable deletion and phoneme deletion is .74 & .92, respectively.

In the phoneme synthesis task, the children were asked to isolate the phonemes that made up the non-words. There were six practice items. The test items consisted of 1-2 syllables, 2-5 phonemes. Length increased from 2 to 5 phonemes. (test reliability .82)

Text reading

The participants were asked to read texts at their level of competence. The texts were chosen based on the judgment of six language teachers who were asked to evaluate 7 texts for their appropriateness to the reader's grade level. The three most appropriate texts were chosen. Participants in third-grade were asked to read one text, and the fifth- graders were

asked to read two texts: one vowelized, and one unvowelized. This is because most of the material taught in fifth grade is unvowelized and it was important to compare these two forms of orthographies. The numbers of deviations from print were recorded and the time it took the participants to read each text was also recorded. A stopwatch was used to record overall reading time, in minutes, for each text.

Procedure

Prior to testing, all measures were piloted in both third and fifth grade (26 children) on a comparable sample in order to weed out measures that did not match the children's level. All measures were administered at the end of the school year during the months of May and June 2008. Children were tested individually in a quiet room at school. Data collection took place in October and November, a month after the beginning of the school year. Each child was administered all the tasks on the same day. The responses were both tape-recorded and noted on scoring sheets that were cross-validated against the tape recorded responses.

RESULTS

Descriptive statistics for the measures administered to third and fifth graders are presented in Table 1. Different measures were administered for both grade levels in the two reading texts. The majority of reliabilities were moderate to high, with the exception of the phoneme synthesis, which included relatively few items and was quite difficult for most children. It should be noted, however, that the performance in this task was significantly above chance.

Pearson correlations among NS and phonological awareness variables in each grade level

The assumption was that NS and phonological measures interact with grade level. Therefore the relationship among NS and phonological measures was examined in each grade level separately as shown in Table 2. In third grade, there were significant, yet weak, correlations between LNS and all measures of phonological awareness. However, there were no significant relationship between NNS and any of the phonological measures. In fifth grade, there were significant correlation between LNS and two measures of phonological awareness (phoneme deletion and phoneme synthesis), and no significant correlation between LNS and syllable deletion. NNS was weakly correlated with syllable deletion.

Table 1. Descriptive Statistics for all research variables according to grades

	Grade 3 (N=58)			Grade 5 (N=59)		
Variables	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**
Peabody raw score (110 items)	48.00	65.71	8.23	38.00	80.42	9.97
NS:						
LNS time in seconds (50 letters)	84.80	51.98	17.26	52.06	43.40	11.25
NNS time in seconds (50 numbers)	57.81	33.94	9.87	24.98	26.64	4.56
Phonological awareness:						
syllable deletion total (24 item)	17.00	14.91	3.81	16.00	16.53	3.90
phoneme deletion total (24 item)	21.00	9.97	6.00	20.00	13.27	6.36
phoneme synthesis total (13 item)	12.00	7.38	3.00	9.00	9.08	2.48
number of correct words read in text1 (138 word)	42.00	41.69	10.75	114.00	99.85	24.71
time in seconds in text1	164.54	85.61	36.14	261.72	148.72	59.87
number of correct words read in text2 (148 word)				69.00	130.90	15.14
time in seconds in text2				204.30	134.69	49.37

Table 2. Pearson correlations among NS and phonological awareness variables in each grade level

	Grade 3 (N=58)	Grade 5 (N=59)

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	LNS	NNS	syllable deletion	phoneme deletion	phoneme synthesis	LNS	NNS	syllable deletion	phoneme deletion	phoneme synthesis
LNS										
NNS	.43**					.36**				
syllable deletion	-.35**	-.15				-.20	-.27*			
phoneme deletion	-.28*	-.13	.67**			-.35**	-.12	.55**		
phoneme synthesis	-.32*	-.15	.59**	.64**		-.29*	-.21	.49**	.62**	

*p< 0.05; **p< 0.01

Pearson Correlations among letter naming, phonological awareness and reading variables in each grade level

The relationship between NS, phonological measures and reading variables (pseudo-word, single word and text reading) were measured and presented in Table 3. The findings for third grade indicate that LNS scores were significantly correlated with accuracy and fluency of text reading time in seconds (r =.40, p< 0.01). Weaker, but significant correlations were found between LNS and accuracy measures at the text level of reading (r = .26, p< 0.05). The NNS measure, however, was significantly correlated only with fluency measures of text reading (r =.52, p< 0.01). All phonological measures were significantly correlated with accuracy measures but were not correlated with any fluency measure.

In fifth grade, LNS was not significantly correlated with text reading level however, the NNS was significantly correlated with all accuracy and fluency measures except with the accuracy measure at single word level. As in third grade, all phonological measures were significantly correlated with the accuracy measure at text reading. Also, some of the phonological measures were significantly correlated to fluency measure. Some of the strongest and significant correlations were evident among syllable deletion and the two text reading fluency (r =-.35, p< 0.01, r =.42, p< 0.01).

Table 3. Pearson Correlations among letter naming, phonological awareness and reading variables in each grade level

	Grade 3 (N=58)					Grade 5 (N=59)				
	LNS	NNS	syllable deletion	phoneme deletion	phoneme synthesis	LNS	NNS	syllable deletion	phoneme deletion	phoneme synthesis
Text 1-Vowelized										
Accuracy	-.26*	-.12	.35**	.55**	.47**	-.37**	-.32*	.61**	.40**	.53**
Fluency	.40**	.52**	-.16	-.13	-.24	.38**	.46**	-.35**	-.28*	-.36**
Text 2-Unvowelized										
Accuracy						-.16	-.34**	.71**	.49**	.50**
Fluency						.28*	.54**	-.42**	-.24	-.30*

*p< 0.05; **p< 0.01.

DISCUSSION

Phonological awareness and naming speed (NS) are two abilities found to have a strong relationship with reading in many languages [e.g. 28]. Both phonological awareness and NS are key components in the development of reading:

phonological awareness was found to be related to accuracy measures and NS to fluency. However, it is clear that the roles of different aspects of reading vary in their importance and contribution to reading development based on the characteristics of specific languages [29].

Arabic is considered a shallow orthography when it is vowelized, but it is also a diglossic language. These two forces operate on the acquisition of reading and on the development of meta-linguistic abilities [14; 30], in the same manner as that reported for children exposed to two languages [e.g., 30]. In addition to these two forces, recent evidences have attributed a strong effect of visual complexity of Arabic orthography on the development of certain linguistic processes and reading [18; 31].

The main goal of this study was to investigate the relationship between phonological awareness and NS measures, the relationship between these two abilities and reading vowelized and unvowelized texts in the Arabic language in third (vowelized text) and fifth grade (vowelized text and unvowelized text).Three different measures were used to assess phonological awareness: phoneme deletion, syllable deletion and phoneme synthesis. Two measures were used to assess NS ability: letter naming speed (LNS) and number naming speed (NNS).

Our hypothesis about the relationship between phonological awareness and NS measures in third and fifth grade was partially confirmed. LNS was moderately correlated with all phonological awareness measures, yet there was no significant correlation between LNS and syllable deletion in fifth grade. Unexpectedly, NNS was not significantly correlated with any phonological awareness measure, aside for a weak correlation between NNS and syllable deletion in fifth grade. Studies in English also report weak to modest correlations between phonological and NS measures [12; 32; 33]. Cross-linguistic results are supportive. In the German language, Wimmer [34] also found weak interrelationship between NS and three phonological awareness measures among participants in grades two through four.

The change in the relationship between the various phonological awareness and NS measures in the two grade levels can be attributed to the development of both abilities. These developmental changes were witnessed in many studies. In English, Wagner et al. [35] found in their cross-sectional samples of kindergarten and second grade children a change in the relationships between several carefully defined phonological measures and serial NS for letters: the correlations were relatively strong in kindergarten while by second grade most of them failed to reach significance or diminished to modest relationships only.

A large body of research has shown that children's explicit awareness of the phonemic structure of spoken language is related to reading experience [e.g. 36].

According to Breznitz [10], one interpretation of the developmental changes occurring in NS relates to the variable's link to processing speed. Kail [37] claimed that age differences in processing speed could be explained as part of a general developmental change. Kail and Hall [3] claimed that the development of a general speed factor among regular readers explains the changes in NS. Their study of 144 children, age 8 to 13, using general processing time measures, naming measures, and various reading measures, found increase of age, accompanied by systematic increases in speed of processing, NS, and reading ability.

In the Arabic language, different studies have demonstrated a unique effect of the diglossic nature of Arabic on the development of different meta-linguistic and reading. Eviatar and Ibrahim [30] examined meta-linguistic abilities of Arabic-speaking children and found apparent effects of age in the measures of phonological awareness. In their study, first graders performed at a higher level than kindergartners on all measures of phonological awareness. They attributed this effect to becoming literate (p.462). They further claimed that exposure to literary Arabic in early childhood affects meta-linguistic skills in the same manner as that reported for children exposed to two languages. Thus, the age factor in examining meta-linguistic skills for Arabic speaking children is crucial. Children with age are more exposed to their "second language". This exposure affects the development of these skills and hence affecting their predictive power over the years.

The second hypothesis was related with the relationship between phonological awareness, naming speed and reading texts. We predicted that phonological awareness variables will correlate with accuracy measures, and that NS variables will correlate with fluency measures. This hypothesis was partially confirmed. In third (vowelized text) and fifth grade (vowelized text and unvowelized text), all phonological awareness measures were significantly correlated with accuracy measures, and both NS measures were significantly correlated with fluency. These results indicate that phonological processing skills are crucial for decoding skills and that naming speed ability is crucial for the fluency aspect of reading. However, unexpected correlations were witnessed between the various measures phonological awareness and NS and reading. In third grade (vowelized text), LNS significantly correlates, although modestly, with accuracy. In fifth grade, NS correlates with accuracy in reading vowelized and unvowelized texts. Similar results were found in other transparent orthographies [12]. This greater role played by NS measures in reading (the connection between NS measures and accuracy) was witnessed in other transparent orthographies such as German [38], Spanish [39], Chinese and Hungarian [40].

Dissociation between LNS and NNS was also witnessed in the third grade. While both measures correlate with fluency, only LNS correlated with accuracy. Most research didn't differentiate between letter naming speed and number naming speed but rather treated them as a one unitary alphanumeric ability. Van den Bos, Zijlstra, and Spelberg [41] addressed this issue and examined closely the interrelations between continuous-naming tasks. They noted that conclusions in various previous studies were based on rather superficial evidence. That is, the relative closeness of mean NS of numbers and letters on the one hand and the relative closeness of color-and picture-naming speeds on the other hand were considered sufficient basis for distinguishing alphanumeric and nonalphanumeric composite scores [42]. In their study they found an unstable pattern at the levels of 8- and 10-year-olds, whereas easily interpretable and stable two-

factor pattern emerged at the age levels of 12, 16 and mature adulthood. Thus, developmentally, an increased common speed factor can be observed as well as differentiated and increasingly independent pattern of alphanumeric associations. They interpreted the later finding as reflecting a gradual strengthening of initially loosely connected alphabetic and numeric access routes into an integrated alphanumeric lexical network. They further argue that this development can be explained by the hypothesis that letter- and number-naming speed interact with both reading and arithmetic practice.

In this study, three phonological measures were used, with different patterns of correlation results. In literature, evidence has been inconclusive about which features of phonology are essential to early word reading. In this study, the strongest predictor of accuracy to text reading in third grade was phoneme deletion. In fifth grade, of the three phonological measures, syllable deletion and phoneme synthesis revealed stronger correlations with accuracy and fluency.

Most studies that investigated the relationship between phonological awareness and reading in Arabic did not seek to understand which aspects of phonological awareness are related to reading, instead they examined this ability as one of several others. For example, Mannai & Everatt [43] investigated phonological processing skills as predictors of literacy amongst Arabic-speaking Bahraini children, using word and non-word rhyming tasks tests to assess phonological awareness were. They found that these two tasks were highly predictive of word reading and that grade effects were also apparent in the data (non-word rhyming seemed to be more important in first grade, whereas word rhyming was a reliable predictor of word reading in second and third grade).

Ibrahim & Eviatar [44] also found different results with various phonological measures and their relation to reading. They examined the relation of three phonological measures to reading: initial phoneme detection, final phoneme deletion, and syllable deletion task and found a relationship in first grade Arabic readers only between the syllable deletion task and text reading (rate and accuracy) and no relationship between the other phonological measures and their text reading ability. On the single word level, they found a strong correlation between word reading and all phonological measures. And on the non-word reading, they found a strong correlation between syllable deletion and non-word reading and 2-syllable final phoneme deletion and non-word reading.

Another possible explanation for the increased variance explained by phonological awareness measures in fifth than in third grade, is derived from research that focused on the characteristics of the Arabic orthography.

Previous research has suggested that Arabic requires more visual attention than Hebrew [18; 45], allowing visual processing to have a greater effect on reading. It seems that in third grade, these visual processes play a greater role than in fifth grade. Ibrahim & Eviatar [44] found that the higher visual complexity of the Arabic orthography results in a smaller effect of phonological awareness among Arabic children in the first grade on reading levels, than for children who are reading Hebrew.

This phenomenon was further elucidated in a study by Abdelhadi, Ibrahim and Eviatar [46] on the effects of orthographic complexity and lexical status on vowel detection in Arabic and Hebrew in third and sixth grade children. The authors hypothesized that the complexity of the Arabic orthography would result in a high perceptual load, contributing to the difficulty and slowness of processing in reading in Arabic . They used a vowel detection task : FatHa “ “ in the Arabic stimuli and the patah “ ̲ ” in the Hebrew stimuli. In each language one-third of the elements were real words, one-third were pseudowords, and one-third were comprised of nonletter stimuli. Half of them included the target: fatha in Arabic - ́ ,and patach in Hebrew - ◌ ̲. Three versions were created in Arabic, varying in orthographic complexity: nonconnecting letters, connected and connected letters without dots, and connected letters including dots. The children had to determine whether a specific vowel (“fatHa” in Arabic stimuli and “patah” in Hebrew stimuli) was present or not in each stimulus. Stimuli were presented in the center of a computer screen and remained until the child pressed the proper button on the keyboard (yes/no). The median response times and sensitivity (d’) was measured in each condition. The children responded faster in the Hebrew condition than the Arabic condition. In addition, there was no word or letter superiority effect in Arabic. These results could be construed to mean that reading mechanisms were not engaged. However, the finding that children responded fastest to the connected stimuli, which are most frequent in Arabic orthography, suggested that the reader’s cognitive system is organized to perceive the connected stimulus as a default. According to the investigators, had we been seeing only visual processes, the simple conditions of Arabic and Hebrew should have been the easiest conditions in which to detect the target. The authors suggested that this may reflect the complex visual processing that occurs before and in tandem with the engagement of reading skills. Although they chose children who are reading at grade level, it may be the case that reading processes take longer to be automatized in Arabic.

This claim can be supported by other studies which showed that reading processes in Arabic takes longer to be automatized. Azzam [47] examined the errors in reading and writing made by children learning Arabic in a developmental framework and found that errors in reading and spelling persisted throughout elementary school, pointing to the difficulties involved in mastering the Arabic written language. A more recent study conducted by Abu Ahmed, Share & Ibrahim [48] also found that accuracy of Arabic word and pseudo-word decoding at the beginning of grade 2 was low when compared to word recognition in other orthographies, with children committing one error every three words. They concluded that Arabic-speaking children living in Israel have not yet mastered the alphabetic code at the beginning of grade 2. An additional finding related to this point is the dominant role played by phonological measures in explaining reading accuracy compared to the less dominant role played by NS measures in explaining reading fluency. This finding contradicts the pervasive view that NS plays a greater role in shallow orthographies and rather reinforces the prominent role of phonological awareness in Arabic.

To conclude, the main goal of the present study was to explore two abilities: phonological awareness and naming speed that are considered main predictors of reading in many orthographies, taking into consideration the main features of the Arabic language. With respect to this, several conclusions can be drawn accordingly:

First, low level processes (phonological awareness and naming speed) are key components of reading in Arabic. The findings illustrate the importance of using phonological awareness and NS measures as assessment tools in Arabic. Second, based on the results of the present study it seems more accurate to conceptualize naming speed and phonological awareness skills as assessing separate abilities, rather than as assessing one general phonological ability.

Third, although vowelized Arabic is considered a shallow orthography, it seems that the diglossic nature of the language and its visual complexity have greater impact on the development of these meta-linguistic abilities and their relation to reading.

Finally, specifying the units of phonological processing responsible for dyslexia, and how these may lead to differing incidence/level, may prove vital for the identification of dyslexia across different countries, as well as for the development of effective literacy programs in different languages. These language differences will most certainly impact on remediation strategies.

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