The orthographic depth and promotion of students with learning disabilities

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Abstract: This research examines the connection between orthographical depth of a language and phonological and morphological processing in Arabic-speaking children with learning disabilities. Participants included 40 pupils in third and fourth grade with learning disabilities in reading and reading comprehension studying in a mixed class in regular Arab elementary schools. The effect of the orthographical depth of the language was tested in two research groups: 20 pupils learning to read in Arabic with full vowelization and 20, with partial vowelization. Phonological and morphological processing were each tested with two tasks: Phonological processing was tested by phonetic parsing of words and in the second task, phonetic parsing of nonsense words. Morphological processing was tested with morphological production and judgment of morphologic relations. The first hypothesis of this research claims that the level of phonological processing of Arabic-speaking children learning to read Arabic with full vowelization will be higher than in the group with partial vowelization. The second hypothesis claims that among the pupils who learn to read Arabic with full vowelization, the morphological processing will be higher than with pupils learning to read with partial vowelization. The third hypothesis claims that orthographical depth is a more significant predictor of phonological and morphological processing than variables related to the personal background of pupils with learning disabilities. These findings can enhance our understanding of the processes that are the bases of phonological and morphological processing, and will enable us to develop ways to improve the reading comprehension of pupils with learning disabilities in mixed classes in regular Arab elementary schools. Furthermore, these findings will contribute to development of teacher training with a focus on effective ways of advancing phonological and morphological processing and reading comprehension in students with learning disabilities.

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PUBLIC INTEREST STATEMENT
This research examines the connection between orthographical depth of a language and phonological and morphological processing in Arabic-speaking children with learning disabilities. Participants included pupils with learning disabilities in reading and reading comprehension studying in a mixed class in regular Arab elementary schools.

These findings can enhance our understanding of the processes that are the bases of phonological and morphological processing, and will enable us to develop ways to improve the reading comprehension of pupils with learning disabilities in mixed classes in regular elementary schools. Furthermore, these findings will contribute to development of teacher training with a focus on effective ways of advancing phonological and morphological processing and reading comprehension in students with learning disabilities.
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Subjects: Education Studies; Primary/Elementary Education; Educational Psychology

Keywords: orthographical depth; phonological processing; morphological processing; learning disabilities

1. Introduction
This research examines the connection between the orthographical depth of a language and phonological and morphological processing in Arabic in pupils with learning disabilities in the area of reading and reading comprehension in mixed classes in regular elementary schools.

Phonological processing is the ability to relate to the smallest sound units of a language, with attention to meaning. It is an extremely important predictor of reading comprehension and academic achievement (Levy-Shimon, 2005; Taha, 2009).

Morphological processing, on the other hand, relates to the ability of pupils to be aware of the internal morphology of words, and their ability to make use of these morphological structures (Taha, 2009).

One of the important characteristics of written Arabic is the addition of vowel symbols next to the letters, which comprise words and sentences. This vowelization is a helpful tool for correct reading both for beginners and even for more advanced readers. Without vowelization, it is possible that a word can be read in different ways with different meanings. The addition of these vowels improves the chances of correct identification of words in isolation. It is important to emphasize that words can be written with partial vowelization or without vowelization, but the addition of vowels facilitates the precise reading of a word and improves the phonological processing of the reader. Likewise, vowelization makes it easier for the reader to recognize the internal structure of the word and in so doing improves morphological processing skills (Amer, 2003).

Studies have shown that phonological and morphological processing are acquired language skills, which can be improved. Recognizing the underlying processes that form the bases of the connection between orthographical depth of written Arabic through vowelization and the language skills necessary to strengthen the awareness and raising the awareness of teachers, will improve the language abilities of pupils. Furthermore, it will enable us to plan an educational program to meet the needs of pupils with learning disabilities struggling with reading and reading comprehension.

2. Arabic language and its orthographical depth
Arabic is a language at the southern branch of Western Semitic languages. Literary Arabic primarily functions in its written form serving as the basis of communication throughout the Arabic-speaking world. Most significantly, it plays an important role in the lives of Muslims, since it is the language of the Koran. Alongside literary Arabic is the spoken language (Abu-Rabia, 2000).

Arabic has a religious function. As the language of the Koran, it is considered the holy tongue of Islam. According to Islam, God gave the Koran to the prophet Muhammed in Arabic. Every translated version of the Koran is considered deficient. Arabic is the language of prayer of Muslims, and every Muslim is required to know the language.

Written Arabic consists of an alphabet of 28 letters, additional graphic symbols that represent vowel sounds, doubling of consonants, absence of a vowel (schwa) and more. The letters themselves
represent consonants, but three of these consonants can sometimes be used as vowels (similar to the “y” in English).

Arabic is written from right to left, similar to other Semitic languages, and the letters are attached as in script. The letters can be written in various ways at the beginning, middle and end of words. However, Arabic has six letters that are never connected on the left. In Arabic, there are two types of writing systems, with vowelization and without. Arabic vowels consist of symbols next to the letters, which determine the way the word is read. Certain letters in Arabic have the same basic shape, and it is the vowels that distinguish between them. The written language can be displayed with or without vowelization or with partial vowelization. The difference reflects what is known in the literature as “the orthographical depth of the language” a term used to describe the differences among orthographies of different languages (Ben Hor, 2009; Ravid, 1996). The addition of vowel symbols in Arabic is meant to make reading easier and to facilitate correct pronunciation.

The Arabic language is considered to be a regular alphabetic language—that is, there is a close connection between the graphic representation of the language (the visual aspects) and the phonemic (the sound aspects). The connection between the letter and the sound demands that the reader know the rules. There is no need to remember exceptions, analogies, or rules upon which they are based. Knowledge of complex orthography is connected by way of “silent” letters that appear in writing, but are not pronounced, or homophones (letters with identical sounds (Abu-Rabia, 2000; Bishara, 2005)).

3. Phonological processing and the orthographic depth of a language

Phonology is the information about the sounds of the language. Phonological awareness relates to the ability of children to distinguish, to process, and to use sub-lexical elements of the spoken language, such as syllables, rhymes, and phonemes. Phonological processing is the ability to carry out mental operations on parts of speech, deletion of beginnings, middle or ends of words, and the ability to carry out different actions with sub-units (synthesis, analysis, reduction, addition, reversal of phonemes and more) (Geva, Wade-Wooley, & Shany, 1993; Koda, 1997).

Phonological processing can be described as the ability to decode graphic-phonemes using the conversion of letters to sounds. Phonological processing is the ability to rhyme, identify sound patterns in rhymes, the ability to separate words into syllables, and the ability to combine syllables to create sounds and words. Phonological processing is part of the linguistic ability that develops in kindergarten age children when the child is first exposed to reading, and its importance grows in elementary school when children are expected to begin to read. Phonological processing helps children read and comprehend, and reading has an impact on phonological processing (Ravid & Tolchinsky, 2002; Taha, 2009).

Vowelization makes it possible to identify the phonological information of the word accurately assuring that the correspondence between the written word and the sound of the word is consistent and absolute. In contrast, in the unw vowelized language, or in the partially vowelized language, phonological information is missing and is not absolute (Ravid, 1996).

Phonological ability is related to reading comprehension and is a predictor of successful reading comprehension in elementary school among good readers and struggling readers alike. Research has shown that training in phonological awareness advances reading comprehension (Karmiloff-Smith, 1992; Levy-Shimon, 2005).

Engen and Hoien (2002) conducted a study comparing fluent readers with disabled readers in first grade. They found a link between phonological awareness and the ability to recognize written words. However, among both good readers and struggling readers, phonological ability helped explain the differences in reading comprehension independent of word identification ability. Accordingly, vowelization is necessary in this age group to promote correct reading (Engen & Hoien, 2002).
Ziegler and Goswami (2005) claim that acquisition of a language affects the development of phonological representations. The awareness of sounds and recognition of the sounds of the various phonemes does not develop automatically. The development of phonemic awareness at the level of basic sounds requires direct teaching. Learning the letters, writing the syllables and words, and the addition of vowels contribute to the development of phonological awareness. Vigler and Goswami have also shown that understanding the connection between the sounds of the language and their written representation (symbols) can be helpful in reading and spelling and enable readers to learn to read and write thousands of words. The process of parsing sounds according to their symbolic representation during reading is called phonological recoding (Ziegler & Goswami, 2005). In order for children to succeed in internalizing the principle of the grapheme-phoneme relationship and to apply it in practice while they are reading and spelling, they have to arrive at a level of correct phonological awareness of the sounds and the structure of words in their language (Taha, 2009).

4. Morphological processing and the orthographic depth of the language

Morphology is the area of linguistics dealing with the way morphemes are combined to make words. In every alphabetic language, words are formed from a number of morphemes, which are the smallest meaningful segments of a language. Morphemes are combined to give words their full meaning. A word can consist of a single morpheme or a combination of morphemes. Morphological information is the ability to relate to the segments of a word and their function (root, tense, affixes, etc.). That is, knowledge of the internal structure of words and the rules enable us to produce words. Morphology relates to the smallest meaningful units of a word and can include a letter symbolizing, for example, the feminine form in Arabic, or more than one letter up to a complete word such as (house) (Bar-On, 2010; Saiegh-Haddad & Geva, 2008).

Morphology relates to two types of morphemes: bound and free. Free morphemes create new words by adding affixes to the root or the base to create an independent word. The affix or morpheme changes the meaning of the base word and, at times, its grammatical classification. On the other hand, a bound morpheme is an affix that is added to the word to indicate tense, gender, number and person. The meaning of the word is preserved, but the additional information relates to the word from a different perspective (Abu-Rabia, 2008; Schwartz-Nachshon, 2009). Arabic, as other Semitic languages, is rich in morphology since a great deal of information is contained in its morphemes such as declension (person, gender, number and time), case (number, gender, possession), roots conjugations, etc (Abu-Rabia, 2008; Carlisle, 2000).

The addition of vowels improves our ability to understand a word and its components, and our ability to understand the meaning of new words, improves morphological processing, and contributes to the acquisition of reading, enriches vocabulary, writing, and reading comprehension. In research comparing children with learning disabilities some of whom read texts with full vowelization and others with partial vowelization, findings showed that those who read with full vowelization read more accurately and are more successful in other language related tasks including reading comprehension. The link between vowelization and morphology is explained by the way the child analyzes words and their morphological components to understand their meaning (Ben-Dror, Bentin, & Frost, 1995; Saiegh-Haddad & Geva, 2008).

Moreover, understanding the morphology of words contributes to the development of an accurate lexicon. Understanding the structure of the roots of a word and the ability to separate the root from the affixes, enable us to identify its correct place in the lexicon (Carlisle, 2000; Ellis, 1999).

Elbro and Arnbak (1996) point out the importance of morphological awareness and its contribution to the reading and spelling process. According to them, morphological awareness enables us to acquire orthographic structures, which are important to reading and spelling, and helps us arrange a lexicon and orthography based on morphologic patterns which facilitate our understanding of the meaning of words while we read.
Research relates to the morphologic-orthographic structure of words, such as, the ability to separate between the letters of a word and its root. Awareness of structure assists us in storing the word in our orthographic-morphologic lexicon, necessary for spelling and developing literacy skills. The importance of understanding morpho-orthographic structure of words is prominent in children with learning disabilities in reading who depend on morpho-orthographic knowledge to spell (Abu-Rabia, 2010; Gerber, 1993).

The preceding literature survey emphasizes the importance of morphologic for the acquisition of reading, spelling and reading comprehension. Morphologic understanding contributes to the identification of word components and their function and in this way, contributes to our knowledge of word meanings and successful reading.

5. The orthographic depth of a language and phonological and morphological processing in students with learning disabilities

Many studies have examined the link between vowelization in written Arabic and phonological and morphological processing, but few studies have investigated this link in students with learning disabilities. Carlisle (2000) has pointed out that morphological awareness is based on phonemes and syllables, and the two-way connection between phonology and morphology promotes reading success. When participants are asked to produce a root word from a base word they have to use their morphologic knowledge to arrive at the correct phonology from a selection of free and bound morphemes, and to read it correctly following internal changes in the letters of the words or the addition of additional letters. Sometimes the same letter appears in certain words as an affix and in other words as part of the word. The ability to parse words is related to the extent of knowledge and fluency of the child with the constituents of the language, and for that reason, vowelization in the written language can contribute to comprehension and production of words and correct recognition and production of their derivatives (Carlisle, 2000; Gass, 1988).

The process of reading acquisition emphasizes the importance of phonological processing and phonological awareness of the sounds of the language. Reaching that goal necessitates acquisition of the orthographic structure of the word that depends on the orthographic depth of the language, the presence or absence of vowelization, strong and weak letters and more. Orthography has an impact on learning, and reading strategies are related to the orthographic depth of the language in which we are reading (Michalsky, Mevarech, & Haibi, 2009).

The addition of vowelization to words provides total phonological information about the word making consistent, unequivocal mapping of the word possible (Ravid, 1996). When a word has multiple meanings in its written form, without vowelization and when it appears with no clear context, vowelization is the only way to clarify its meaning. The inclusion of vowel symbols provides phonological information to readers making accurate reading possible. While partial vowelization increases reading speed, its effect is limited in phonological and morphological decoding, making its contribution to children with learning disabilities less significant than full vowelization (Ball, 1993; Tannock, 2013).

Students with learning disabilities suffer from learning, social, behavioral and emotional difficulties. Adding full points in writing with writing sentences that are clear in terms of their structure and meaning can help greatly in understanding the content (Bishara, 2005).

Taha (2009) emphasizes the importance of visual processing among students with learning disabilities. The importance exists when the reader manages to read the new words and the words of prayer. Hebrew orthography requires the reader to activate the visual processing at the same time as phonological processing and morphological processing, which is reflected in the student's ability to be precise in reading words and understanding them.
Children with learning disabilities require specialized teaching approaches to close the learning gap. Using effective methods and adapting the material to the level and ability of the child gives them with the opportunity to perform mathematical operations in their head, and solving word problems more easily. This approach helps pupils develop a positive, healthy self-image, strengthen social ties, and overcome fear and anxiety associated with learning (Bishara, 2005; Kellerman, 1995).

In this research, I examined the connection between the orthographic depth of a language and phonological and morphological processing in pupils with reading disabilities in mixed classes in regular elementary schools. Understanding this connection can make an important contribution to the curriculum of these children. Furthermore, it will make it possible to identify the specific focus of the difficulty of such pupils in reading and reading comprehension.

6. Research hypotheses

(1) Among pupils who learn to read in Arabic with full vowelization, the level of phonological processing will be higher than among pupils with partial vowelization.

(2) Among pupils learning Arabic writing with full vowelization, the level of morphologic processing will be higher than among those with partial vowelization.

(3) The orthographic depth of a language is a strong predictor of phonological and morphological processing, more significant than other variables such as the individual background of the pupils with learning disabilities.

7. Participants
Forty native Arabic-speaking pupils participated in this research project: twenty-two boys (55%) and 18 girls (45%) diagnosed with disabilities in reading and reading comprehension who were assigned to a mixed class (third and fourth grades) in a regular Arab school in the center of Israel. The pupils had started to read in their native language in first grade. However, they were exposed to phonological and morphologic awareness in kindergarten and even the year prior to kindergarten.

Cognitively, the children were in the normal range (normal cognitive functioning), but in the area of Arabic language, they had difficulties in reading and in reading comprehension, and they had a limited vocabulary. They knew the letters and the alphabet, but did not have complete understanding of the conjugations and made numerous spelling errors. The socio-economic level of the participants in the study was average. Most of the mothers did not work outside of the home; the fathers were employed and earned average salaries. Culturally, the pupils in the study belong to a conservative, traditional society, and their beliefs, behavior, world outlook is consistent with those of their parents and the surrounding society. There was an equal number of boys and girls in both groups (55% boys and 45% girls).

8. Research tools
Three research tools written in Arabic were selected:

(1) Texts with full vowelization and partial vowelization: Texts were selected from the school curriculum.

(2) A test on phonological processing: Phonological processing was examined with two tasks: parsing words by phonemes and parsing nonsense words by phonemes. The test included a list of 40 words in Arabic, 20 real words and 20 nonsense words. The listed was taken from a study of Taha (2009).

(3) A test of morphologic processing: Morphologic processing was tested with two tasks: morphologic production and judging morphologic relations. The test included a list of 40 Arabic words, 20 words to check production and 20 to check ability to judge morphologic relations. The list of words in Arabic was taken from the research of Taha (2009).
The research tools were internally consistent according to Chronbach’s alpha test (a): The Alpha Reliability Factor was 0.82, for phonological awareness and 0.76 for morphological awareness.

9. Research methods
The chief investigator met with the pupils in their schools and tested both groups of pupils: one group learning to read Arabic with full vowelization and the other with partial vowelization. The pupils answered questions they were asked. Reading tests in the phonological area and other tasks in the morphological area were administered to determine the effect of vowelization on phonological and morphologic awareness. The order of the tasks was random.

10. Data analysis approach
A description of the research variables was done by calculating averages and standard deviations. The relationships between the study variables were examined using Pearson’s correlations. In addition, one-way analyzes and multiple regression equations were performed.

11. Findings

11.1. Theoretical statistics
In Table 1, the findings are presented with the standard deviation of the measures of phonological processing (Dividing words into phonemes, Dividing nonsense words into phonemes) and the measures of morphologic processing (Morphological production, Morphological judgment) from the entire sample.

From a glance at the averages presented in Table 1, we can see that the average grades in phonological and morphologic processing ranged from 15.45 – 16.08. Based on the Skewness measure, the division of grades among participants in all four measures was close to normal and symmetrical (The range of values on the Skewness measure were SES = .37, 0.32–0.02).

Table 2 shows the correlation between the measures of phonological processing and measures of morphologic processing in the entire sample.

A glance at the figures displayed in Table 2 shows a strong positive correlation between phonological and morphologic processing. The range is from 0.71 to 0.83.

12. Phonological processing according to the orthographic depth of a language
The first assumption of the research is that in pupils learning to read Arabic with full vowelization, the level of phonological processing will be higher than those learning with partial vowelization. In order to test this, we used different analyses such as the MANOVA Unidirectional. Dependent variables were measures of phonological processing (phonetic parsing of words and phonetic parsing of nonsense words). The independent variable was the depth of the orthography of the language (full or partial vowelization).

| Table 1. Averages and standard deviation of measures of phonological and morphologic processing Sample (N = 40) |
|---------------------------------------------------|------|------|
| Measures of phonological processing               | M    | SD   |
| Dividing words into phonemes                       | 16.08| 1.67 |
| Dividing nonsense words into phonemes              | 15.48| 1.83 |
| Measures of Morphological processing               |      |      |
| Morphological production                           | 15.58| 1.74 |
| Morphological judgment                             | 15.45| 1.95 |

The range of grades was between 0–20 and the higher the grade, the higher the level of phonological or morphological processing.
In analyzing multiple variables (Multivariate Test), phonological processing was measured simultaneously as one index, and a significant difference was found based on the orthographic depth of the language $F(2, 37) = 56.32, p < .001, \eta^2 = 0.75$.

Table 3 presents the averages, the standard deviation, $F$ values of values $\eta^2$ (Univariate Tests) and the size of the effect of phonological processing by group.

A glance at the values of the various analyses presented in Table 3, shows that in the two measures of phonological processing significant differences were found between the two groups. A careful look at the data shows that, consistent with our assumption, both measures of phonological processing were higher for the participants who learned to read in Arabic with full vowelization than in the group that learned with partial vowelization.

13. Morphologic processing by orthographic depth of the language
The second research assumption claimed that among participants learning to read in Arabic with full vowelization, the morphologic processing would be higher than among participants learning to read with partial vowelization.

In order to examine this assumption we used various tests such as MANOVA

Unidirectional. The dependent variables were measures of morphologic (morphologic processing processing and judgment of morphologic relations). The independent variable was the orthographic depth of the language (full or partial vowelization).

In the Multivariate Test, various measures of morphologic processing were tested simultaneously as one index. A significant difference was found based on the orthographic depth of the language $F(2, 37) = 59.71, p < .001, \eta^2 = 0.76$.

### Table 2. Matrice intercorrelation between measures of phonological processing and measures of morphologic processing in the sample. Sample (N- = 40)

|                        | 1       | 2       | 3       | 4       |
|------------------------|---------|---------|---------|---------|
| **Phonological Processing** |         |         |         |         |
| 1. Parsing phonemes of words | —       |         |         |         |
| 2. Parsing phonemes of nonsense words | .76*** | —       |         |         |
| **Morphological Processing** |         |         |         |         |
| 1. Production           | .78***  | .83***  | —       |         |
| 2. Judging relations     | .71***  | .80***  | .84***  | —       |

***$p < .001$.

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### Table 3. Averages, standard deviation, and $\eta^2$ values of phonological processing by group

| Measures of phonological processing | Research groups | F(1,38) | $\eta^2$ |
|------------------------------------|----------------|---------|----------|
|                                    | Partial vowelization | Full vowelization |         |
|                                   | M     | SD    | M     | SD    |         |
| Phonemic parsing of words          | 14.70 | 0.86  | 17.45 | 1.00  | 86.9*** | 0.69   |
| Phonemic parsing of nonsense words | 14.05 | 1.00  | 16.90 | 1.25  | 63.31***| 0.62   |

The range of grades was between 0–20 and the higher the grade, the higher the level of phonological processing.

***$p < .001$. 

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A glance at the measures of the various tests presented in Table 4, shows that in both tests of morphologic processing strong differences were found between the two groups. A careful look at the data reveals that, consistent with our assumption, both measures of morphological processing were higher in the group that learned to read in Arabic with full vowelization than with partial vowelization.

14. The importance of orthographic depth as a predictor of phonological and morphologic processing

Our third assumption claims that there is a positive correlation between the orthographic depth of a language and phonological and morphological processing, beyond that of the variables related to the personal background of pupils with learning disabilities. In order to test this assumption, a series of multiple regression equations were used.

The predictive variables were related to gender and orthographic depth. The predicted variables measured were phonological and morphologic processing. For every predictive variable, regressive equations were measured separately. Table 5 presents the findings of regressive equations.

A glance at the regressive equations in Table 5 shows that, consistent with our assumption, orthographic depth of a language was a strong predictor of phonological and morphologic processing. The percentage ranged from 0.62 to 0.74 from the regressive equations, very significant results.

15. Discussion and summary

This research examined the connection between the orthographic depth of a language and phonological and morphologic processing in pupils with learning disabilities. In testing the connection between orthographic depth of a language and phonological processing, the pattern of results completely confirms the assumption. Among pupils who learned to read Arabic with full vowelization, the level of phonological processing was much higher than among those who learned to read with partial vowelization. Furthermore, consistent with our findings, the orthographic depth of the language was a strong predictor of phonological processing. The findings of the study are consistent with findings of previous research that examined orthographic depth of a language and phonological processing (Abu-Rabia, 2008; Ziegler & Goswami, 2005).

A possible explanation for the connection is that in acquiring reading and writing, full vowelization makes it possible to identify all of the phonological information in the word and therefore, the mapping between the written word and the sound of the word is unequivocal. (Ravid, 1996). The awareness of the sounds and the recognition of the sounds of the various phonemes is a necessary condition for reading acquisition. Therefore, this requires direct instruction to acquire sounds and phonemes, learning letters and writing syllables and words, and using scoring contributes to the acquisition of reading and writing (Ziegler & Goswami, 2005). In contrast, without vowelization or...
Table 5. Predictors of phonological and morphologic processing based on gender and orthographic depth of the language (N = 40)

| Predictive | Model A | | Model B | | Model C | | Model D | |
|------------|---------|-------|---------|-------|---------|-------|---------|-------|
|            | B       | SEB   | β       | B     | SEB   | β     | B       | SEB   | β     | B       | SEB   | β   |
| gender     | -0.07   | 0.30  | -0.02   | -0.04 | 0.36  | -0.01 | -0.17   | 0.29  | -0.05 | 0.72   | 0.36  | 0.19 |
| Orthographic | 2.75*** | 0.30  | 0.83*** | 2.85*** | 0.36  | 0.79*** | 2.95   | 0.29  | 0.86*** | 3.10*** | 0.35  | 0.81*** |
| R²         | 0.70    |       | 0.62    |       | 0.74  |       | 0.68    |       |       |        |
| F          | 42.28*** |      | 30.84*** |      | 53.00*** |      | 40.08*** |      |       |        |
| df regression | 2     |      | 2       |      | 2     |      | 2       |      |       |        |
| df residual | 37     |      | 37      |      | 37    |      | 37      |      |       |        |

Results of the variables: Model A—phonemic parsing of words; model B—phonemic parsing of nonsense words; model C—morphologic production; model D—judging morphologic relations; gender (0 = females, 1 = males); orthographic depth of the language (0 = partial vowelization; 1 = full vowelization).
with partial vowelization, some phonological information is missing and ambiguous, and as a result presents difficulties for readers (Ravid, 1996; Taha, 2009).

Examining the connection between deep orthography of a language and morphological processing, the findings completely confirm our assumption. Consistent with our assumption, among pupils who learned to read Arabic with full vowelization, the level of morphologic processing was higher than in those who learned to read with partial vowelization. Furthermore, consistent with our assumption, orthographic depth of the language was a strong predictor of morphological processing. This finding confirms the results of previous published research on the connection between the orthographic depth of a language and morphological processing (Ben-Dror et al., 1995; Saiegh-Haddad & Geva, 2008).

A possible explanation is that vowelization simplifies the analysis of the morphologic constituents of words and as a result, improves morphologic processing. Vowelization enhances the efficiency required to identify word roots and their derivatives and improves the ability to understand words and their components. Correct identification of conjugations and affixes, and recognizing semantic meanings of different forms of the word facilitates correct reading of words and correct identification of the meaning of the word and its derivatives. (Abu-Rabia, 2009; Saiegh-Haddad & Geva, 2008). The link between morphological awareness and the acquisition of reading and scholastic success is of great importance. Therefore, in order for learners to understand complex words, they must first use morphological information. Using the morphological information, we can identify the roots and the numerals and the semantic meaning of the words that can assist in reading the complex words and identifying the meaning of new words and as a result understanding all the text (Abu-Rabia, 2009).

The Arabic language has a rich morphology since it is highly inflected with affixes indicating transitions, person, gender, number and tense, possession, roots, and different forms of conjugations (Haddad Center, 2012; Taha, 2009). It is extremely important to recognize the morphology of the language. Our research indicates that vowelization is a very important factor in improving morphologic processing.

16. Conclusions and recommendations
The process of acquiring reading emphasizes the importance of phonological processing and phonological awareness as well as recognition of the morphological structure of words.

Pupils with learning disabilities, who have difficulties learning to read often lack phonological and morphological awareness and encounter difficulties in phonological and morphological processing (Abu-Rabia, 2000). This disability impairs their decoding of the phonological and morphological elements of words at the time they are learning to read, and impairs language processing including higher-level processes such as reading comprehension.

Our research raises the possibility that there is a link between the orthographical depth of a language and phonological and morphological ability among third and fourth grade pupils with learning disabilities in reading and reading comprehension.

In elementary schools in the Arab sector in Israel, vowelization is eliminated after third grade and, as a result, the orthography becomes much more difficult to decode making the acquisition of reading skills particularly difficult for pupils with learning disabilities (Levy-Shimon, 2005).

Full vowelization in third or fourth grade and possibly beyond would provide additional phonological information to pupils with learning disabilities, and contribute to the development of phonological awareness and phonological and morphological processing which are essential for reading.
Partial vowelization is limited in its effect on phonological and on morphological processing, and is therefore less helpful to children with learning disabilities.

Our data emphasize the necessity of adding vowelization during the acquisition of reading skills in Arabic among pupils reading disabilities. Recognizing the linguistic structure of a word from the perspective of orthographic depth and the connection to phonological and morphological processing will significantly improve the academic functioning of pupils with learning disabilities and will contribute to their social and emotional adjustment. The teaching staff of the school can assist these pupils to overcome their difficulties in reading and writing. The data of this study provide a foundation for developing a widespread program in phonological and morphological processing for pupils with learning disabilities at the pre-reading or early stages of reading acquisition.

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