The Role of Morphological Decomposition in Reading Complex Words in Arabic in Elementary School Years

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Abstract

We examined the role of morphological processing in the reading of inflections and derivations in Arabic, a morphologically-rich language, among 228 first-graders and 230 second-graders. All words were morphologically complex, with differences in number of morphemes and morphological transparency. Inflections consisted of three morphemes, with high transparency of the root morpheme, while derivations consisted of two morphemes with lower transparency of the root. Results indicated that, despite their matching in frequency and syllabic length, reading performances of derivations was better than those of inflections. That is, three-morphemic highly transparent inflections were read slower and involved more errors than bi-morphemic less transparent derivations. These differences in reading performance between inflectional and derivational words might suggest that Arab-speaking novice readers use a morphological decomposition process that is reflected in reading accuracy and fluency. The results highlight the important role morphology has in reading, even at a young age, along with reading acquisition.

Keywords Arabic · Morphological decomposition · Complex · Word-reading · Inflections · Derivations · Fluency

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Introduction

Words are assumed to be mentally represented together with detailed reference to their morphemes (e.g., re + cover) (Baayen et al., 1997; Caramazza et al., 1988; Frauenfelder & Schreuder, 1992; Schreuder & Baayen, 1995; Vaknin & Shimron, 2011). Exposure to morphemes in print sharpen such sensitivity further and enables the reader, in an implicit learning process (Vaknin-Nusbaum & Saiegh-Haddad, 2020), to represent sub-ortho-graphic (e.g., morpho-orthographic) components that reflect the morphological structure of words and are associated to phonological units (see for example; Grainger & Beyersmann, 2017; Rastle, 2019; Vaknin-Nusbaum & Saiegh-Haddad, 2020). Such knowledge enables the readers to segment morphologically complex written words (e.g., *farmer*) into their constituent morphemes (*farm + er*) during reading. This "morpho-orthographic segmentation" process is assumed to speed up the reading of morphologically complex words (Rastle, 2019), in particular in writing systems that represent morphemes transparently (Carlisle & Fleming, 2003).

Semitic languages, such as Arabic and Hebrew, although featured by complex morphology, are examples of highly transparent orthographies, in terms of their morph-orthographic structures (Frost, 2012; Taha & Saiegh-Haddad, 2016). It was proposed that during word recognition in such languages, the process depends on all of the available linguistic and orthographic resources, including the morpho-orthographic components of the written words (Frost, 2012). Words in Arabic, the language which is the focus of the current study, are mostly constituted from at least two morphemes: a root and a pattern that are usually merged in a nonlinear procedure. Suffixes can be attached to words linearly, as in the case of inflections (see Arabic morphology section), turning the word structure multi-morphemic (three or more). However, despite its complexity, inflections' structure is considered relatively transparent in writing (Saiegh-Haddad, 2017, 2018; Saiegh-Haddad & Henkin-Roitfarb, 2014), and thus might encourage a process of morpho-orthographic segmentation/decomposition during reading. However, derivations usually include only two morphemes: the root and the pattern morphemes. Such morphemes are often less morphologically transparent in print due to the interference of vowels in the sequence of the root morpheme (Saiegh-Haddad & Geva, 2008). Both aspects of morphology, i.e. the morphological transparency and complexity, can affect the process of word reading. Accordingly, the present study examined how the morphological complexity (the numbers of the morphemes) and the morphological transparency (of the root morpheme) affect the fluency of reading aloud of written words in Arabic among first and second graders, comprised of both typical and poor readers. These grade levels were examined because of their critical stage in reading acquisition, in which morphological processing, even at such an early stage, can be involved in word recognition, and shed light on the development of reading and the role of morphological features in it.

Arabic Morphology and its Role in the Process of Reading

The Arabic language is characterized by both linear and nonlinear formations of morphology. Linear word formation is usually used to inflect words by adding a suffix. Such examples can be seen in plural or possessive inflections that involved, in regular forms, feminine or masculine linear suffixation. For example, *rasma* which mean *'painting'* + the plural

feminine suffix –*at* <ات> results in *rasma: t.* However, note that irregular plural inflections, called broken plurals, involve a different process that includes internal vocalic changes in the stem – a non-linear process. For example, */maktab/* which mean*s 'desk',* gets the broken plural form *maka:teb,* in which the stem's consonants of the noun are interwoven into a broken plural vocalic pattern *CaCCaC* (Saiegh-Haddad et al., 2012). Similarly, possessive inflections are usually created by a suffixation of the noun (e.g., *i* 'my', *na* 'our') according to its grammatical gender. For example, the possessive form that would parallel the English phrase 'my desk' is *maktabi = maktab-i.* Here also some inflections can be considered as irregulars, because their writing involves replacing the last letter of the noun before affixation. For example, the possessive inflection of 'my paint' is *rasmati = Rasma-ti* involves replacing the last letter of the noun, *ta? marbuta* <ة>, with the letter <ت>, also called *ta? maftuha*, and only then adding the right possessive suffix (Saiegh-Haddad & Henkin-Roitfarb, 2014).

The non-linear formation is mainly used to derive words in Arabic in a procedure in which a consonantal root, indicating the semantic family, is interwoven into a vocalic pattern. The pattern can be verbal or nominal, and is composed of vowels and consonants, implying the syntactic and grammatical features of the word. For example, the word *katab* 'write' is created by interwoven the root KTB into the vocalic pattern CVCVC (C stands for the root consonant). Inserting the same root morpheme into a different vocalic pattern will results in a different word meaning. For example, *maktub* 'written' is created by interweaving the same root into the vocalic pattern CVCCVC.

Another feature of Arabic morphology is its tendency to use bound morphemes, enabling the creation of dense words by attaching to the stem prefixes or suffixes that represent time and person. For example, the meaning of the phrase 'and (we) will meet them', can be folded into one complex word, *wa-sa-nanoqa:bilu-hum* (Saiegh-Haddad, 2017).

Although rich and complex, the Arabic morphology appears transparently in print, very often preserving the sequence of the root morphemes that serves as the core of the word and representing the phonological pattern by diacritics (in pointed Arabic) and a consonantal unit (Saiegh-Haddad, 2017, 2018; Saiegh-Haddad & Henkin-Roitfarb, 2014). Thus, taking into account the Arabic morphological features and its transparent representation in print, it is possible to assume that the processing of words involves sensitivity to their structure (linear and non-linear) (Asli-Badarneh & Leikin, 2019) that encourage a procedure of morphological decomposition in novice Arab-speaking readers (Mahfoudhi et al., 2010), a process which is assumed to be associating between words' orthographic level and semantic representation in Semitic languages (Frost, 2012; Frost et al., 1997; Vaknin-Nusbaum & Shimron, 2011). Indeed, morphological processing was found to have a major role in word reading throughout the elementary school year (Asadi et al., 2017a; Shalhoub-Awwad & Leikin, 2016; Tibi & Kirby, 2017), and in a higher reading process such as reading comprehension (Abu-Rabia, 2007; Asadi et al., 2017b; Asadi, 2020; Layes et al., 2017; Mahfoudhi et al., 2010).

In addition to its morphological complexity, Arabic is characterized by a diglossic situation and complex orthography: Diglossia refers to the existence of two forms of the same language (Ferguson, 1959): the spoken and the literary versions, which are used in different situations. Children mainly use the spoken version for oral communication until the pre-school period, and then they start to acquire and use the literary version through formal and more systematic instruction in school. The discrepancy between the two forms is reflected at all linguistic levels (Asadi & Kawar, 2023; Saiegh-Haddad, 2003). As a result, the core linguistic components of Arabic-speaking children may present some immaturities in the literary language which affect the normal development of their oral language (Asadi

& Abu-Rabia, 2019)**.** However, despite the challenge of learning to read in a diglossic language (Asadi et al., 2023), morphology can help in bridging this gap, in particular due to similarities in derivational morphology between the two languages (Vaknin-Nusbaum & Saiegh-Haddad, 2020). Derivational formation, nominal and verbal, in both spoken and standard Arabic, is built by a non-linear procedure in which the root morpheme is interwoven into a word phonological pattern. Although root morphemes frequently differ in both languages, they often share phonological patterns. Moreover, even if some phonetic differences appear between patterns in the two languages, associations between the patterns are transparent (Laks et al., 2019; Saiegh-Haddad & Henkin-Roitfarb, 2014; Saiegh-Haddad & Spolsky, 2014). Due to these features, derivations might be easier to read than inflections for young Arabic-speaking students. Yet this assumption, to our knowledge, has not been tested before. Although it has been found in a previous study that derivational awareness is a better predictor of reading comprehension than inflectional in novice readers, (Vaknin-Nusbaum & Saiegh-Haddad, 2020), the comparison between reading words with different levels of complexity was not yet examined. This might be of importance, since morphological processing is assumed to play a critical role in developing general literacy skills, due to the frequent morphological complexity of the written words that often appear in texts (Saiegh-Haddad & Everatt, 2017).

Morphological Decomposition

According to dual root models, the process of morphological decomposition takes place in the indirect-decomposing route that enables the reader to access word semantic meaning by recognizing its morphemes. This process seems to be very effective when reading unfamiliar, less frequent and complex words. Alongside this indirect route, the direct whole word route is activated, enabling the reader to reach the word's meaning via its orthographic written unit as a whole. Both routes are activated in parallel, but at a different pace, depending on the words' complexity, familiarity, the reader's reading skills and awareness of morphemes, the features of the written orthography, etc. (Baayen et al., 1997; Caramazza et al., 1988; Frauenfelder & Schreuder, 1992; Schreuder & Baayen, 1995). Although such models are based on results from a linear morphology system, evidence from Semitic languages such as Hebrew and Arabic suggest that a similar process occurs while reading non-linear forms in which the word is decomposed into a root and pattern, with the root morpheme providing the core meaning of the word and assumed to be represented in the mental lexicon (Boudelaa, 2014; Frost et al., 1997, 2000; Velan et al., 2005). This might explain why practicing a process of decomposition and composition of complex forms was found to be an effective tool in promoting reading accuracy (Vaknin-Nusbaum & Raveh, 2019) and fluency (Vaknin-Nusbaum, 2021) in disabled readers. Another support for the important role of morph-orthographic units in reading can be found in a broad evidence, suggesting a positive link between awareness of morphemes and elementary school students' reading level (Hebrew: Vaknin-Nusbaum, 2018; Vaknin Nusbaum et al., 2016; Arabic: Asadi et al., 2017a; Saiegh-Haddad & Everatt, 2017; Taha & Taha, 2019).

From a developmental perspective, Share (2018) argues that morphemes representations are built gradually along with reading acquisition, starting the first stages of reading acquisition. This process continues to develop throughout the school years, with the practice of reading, in which each of the read words provides additional support for the representation of morphemes. This morphemes storage, according to Frost (2012), is accessible to the

reader, who recruits all available linguistic information for the act of reading. Such storage can provide valuable information for young readers, who are in the initial stages of developing orthographic representations as a whole. Morphological transparency in print might sharpen readers' awareness to words' structure, and encourage them to use such information to strengthen and enhance phonological decoding (Saiegh-Haddad & Spolsky, 2014)—a strategy that can help overcoming the linguistic distance between spoken and written Arabic forms (Saiegh-Haddad, 2018; Saiegh-Haddad & Taha, 2017; Vaknin-Nusbaum & Saiegh-Haddad, 2020). According to the MAWRID developmental Model in Arabic-speaking children (Saiegh-Haddad, 2018), readers use morpho-orthographic mechanism after basic decoding skills of graphemes to phenomes are acquired (e.g., phonological recoding mechanism). Thus, the role of morphological processing in reading words in Arabic can be of great importance in the first years of elementary school, in which children are in the process of developing basic reading skills and strategies to overcome the distance between spoken and written language.

The Present Study

In the current study, we examined reading performance of written morphologically complex words in Arabic among first and second graders, both typical and poor readers. The main aim of the current study was to examine how Arabic morphological features, complexity and transparency, impact reading accuracy and fluency of words in Arabic. We compared the reading of derivations and inflections matched by word familiarity and syllabic length. The two groups of words, chosen for the current study, differed in level of complexity and transparency. Level of complexity was determined by the number of morphemes appearing in a word. Although, all words consisted of a root and phonological pattern interwoven to each other in a nonlinear procedure, inflections however, created by an additional linear formation of affixation, resulted in a three-morphemic word. Thus, derivations consisted of two morphemes, whereas inflections consisted of three. Level of morphological transparency was determined by the sequence of the letters appearing in the root morpheme. Both inflections and derivations consisted of the same root morpheme, yet, in derivations, the consonantal sequence of the root was interfered by vowels-letters; whereas, in inflections, the sequence of the root letters was intact. In the following example of the derived word a *writer* 'كاتب' (**KATB**), the sequence of the three consonantal root 'ك. ت. ب` (K.T.B), is interfered by the letter 'ا ' (that represents the vowel a) after inserted into the pattern $fa:\mathit{?}el$.

Word syllabic length and familiarity were controlled, enabling us to better focus on how morphological complexity, as reflected in number of morphemes and root transparency, affects word reading in novice readers, who are in the process of reading acquisition. In particular, we examined children's reading accuracy and fluency of inflections and derivations at two grade levels: first and second. In addition, we compared typical and poor readers to see whether reading ability is associated with morphological structure.

It can be assumed that differences in morphological transparency and complexity of the written words might reveal differences in reading performances. On the one hand, due to differences in the transparency of the root morphemes, the morphological decomposition of derivations might be time-consuming, and involve more reading errors, as opposed to inflections, which are more morphologically transparent in print. On the other hand, dual-route morphological models may lead to another possibility. According to such models,

since morphologically complex words are decomposed into their linguistic elements, the time and quality of the process depend on the number of a word's morphemes. Thus, reading of inflections, which consist of three morphemes (versus two in derivations), will result in longer reading time and a higher number of errors, despite their morphological transparency.

Methods

Participants

A total of 458 Arabic-speaking children (208 boys and 250 girls) participated in this study, including 228 first graders ($M_{age\ in\ month} = 83.8$; $SD = 9.5$) and 230 s graders ($M_{age\ in\ month} = 95.6$; $SD = 10.2$). The participants were recruited from 33 Arabic speaking elementary schools from the north, the center and the south of Israel, representing different socio-economic backgrounds. Between seven to eight children were selected randomly from each class by the tester assigned to each school. The research was approved by the ethical committee of the Arab academic college in Haifa, Israel. In addition, children were required to provide a parental consent form to participate in the study. All participants were from regular classes, and none had visual, hearing, language mental disabilities.

Following a conventional practice in the reading disability literature (e.g., Asadi & Shany, 2018; Chua et al., 2016; Wise et al., 2008), to differentiate between typically developing children and those with reading disability (poor readers), the 25th percentile (or below) cut-off for reading fluency (including accuracy and rate) in pseudo-words reading measure (Asadi et al., 2017b) was used to identify poor readers within each grade level. The 30th percentile (or above) was used determined the typically developing children. A total of 112 children met the above criteria for poor readers with 289 children in the typical group. To make sure that inter-correlation between pseudo-words and the performance in each of the morphological tasks was similar, correlational analysis was conducted revealing similar correlations with derivational ($r = 0.72$) and inflectional ($r = 0.75$) performance. This enabled us to ensure that our results would not be influenced by the inter-correlation between pseudo-words and the main two variables.

Measures

Children were asked to read two lists of 30 isolated words, inflected and derived words. Such words differ in their morphological complexity and root transparency. Given the diglossic situation in the Arabic language, and the distance between written and spoken language, the familiarity of the words (both derivational and inflectional) was controlled. This assessment was performed by 57 teachers, who were asked to separately rate the familiarity of the words on a scale between 1 and 5. The paired t-test analysis showed no significant differences between derivational ($M = 3.95$) and inflectional ($M = 3.62$) word familiarity $t(57) = 1.57$, $p > 0.05$.

Since fluency and accuracy were examined separately using the same tasks, a correlational analysis was conducted between those two reading components in each of the word lists (derivations and inflections) to minimize the possibility of multicollinearity between them. This analysis revealed a moderate correlation between accuracy and fluency in both derivational ($r = 0.61$) and inflectional ($r = 0.64$) measures.

Reading words with derivations: This test examined reading accuracy and fluency of derivational isolated words in Arabic. The task consisted of 30 words, an equal number of verbs (15) and nouns (15), that derived from different (30) three letter roots. All derived words consisted of two morphemes: a pattern and a root. The roots were chosen from the children's text books in first grade. Based on the chosen roots, 30 target words were derived non-linearly by using different phonological patterns (such as mɑfˤwːl, fɑːˤel, tɑfɑːˤalɑ).

The nonlinear formation of root and pattern in this list of words resulted in interference to the sequence of the consonantal root morpheme, due to letters that are part of the phonological pattern. For example, by interwoven the root /خ. ر. ج/ in the phonological /فاعل/, we create the word /خارج/ in which the sequence of letters of the root morpheme is not preserved. Word length was between two to four syllables. Overall, the list included 90 syllables. For each list, the participant was required to read aloud the words as accurately as possible at a rate that suited him/her. The participant's score was based on the total number of correctly read items, with a maximum score of thirty. Fluency in reading was computed as the number of correctly read words per minute. The reliability of the test (Cronbach's α) was 0.91 in the first grade and 0.90 in the second grade.

Reading words with inflections: This test examined reading accuracy and fluency of inflectional isolated words in Arabic. The task consisted of 30 words that were inflected from the same three letter roots used in the other list (derivational word reading). Using the same root might reduce differences in the familiarity of the words between the two lists. The inflection of the root was done according to person, number, gender, and tense (past, present and imperative), and similar to the derivational word list, an equal number of verbs (15) and nouns (15) was controlled. Similar to the derivational list, the items included between two to four syllables. Overall, the list included 93 syllables.

The length of the derivation and inflection lists was carefully matched. Unlike in derivations, items are inflected while adding letters at the end (suffix) and to the beginning (prefix) of the words, without interrupting the sequences of the root letters, and thus the orthographic pattern seemed to be more consistent and transparent. For example, if the root was /خ. ر. ج/ and the inflection was for person (we) and time (past), word become /خرجنا/, with suffix (نا). The participant was required to read aloud thewords as accurately as possible, at a rate that suited him/her. The participant's score was based on the total number of correctly read items, with a maximum score of thirty. Fluency represents the number of correctly read words per minute. The reliability of the test (Cronbach's α) was 0.90 in the first grade and 0.87 in the second grade.

Procedure

The participants were tested individually by the examiner in a quiet room in the third trimester (between April and June) of the school year. This was done in one meeting session, with a short break of several minutes between the two lists. In order to prevent order effects, half of the children started with the derivational list and the other half started with the inflectional one. All of the examiners were students in the field of education, and had all received specific and detailed training in administering the different tasks.

Results

Descriptive statistics of reading tests scores are presented in Table 1 for both reading accuracy and fluency. The table presents children's mean performance and standard deviations of derivations and inflections, at both grade levels and in both reading levels groups (typical and poor readers). The results show no indication of either ceiling or floor effects, although the poor readers group, in both grade levels, exhibited lower average score in accuracy and fluency of reading inflections as opposed to typical readers.

Multivariate repeated measures analyses conducted for the all group of participants (first and second grade), revealed a significant main effect for word type and reader type in both reading measures. The effect of the word type condition was due to higher performance in the derivational than that in the inflectional morphology in both groups of readers. However, significant interaction for word type by group was found only for fluency, but not for accuracy (see Table 1).

Grade Level Differences

To examine the differences in grade levels in the impact of morphological word type, two-way ANOVAs with repeated measures were conducted separately for the typical and poor reader groups, both for reading accuracy and fluency. The interaction between word type and grade level was not significant for either the typical readers ($F(1,286)=3.2$, $p>0.05$, $\eta2=0.01$) or the poor readers ($F(1,109)=0.04$, $p>0.05$, $\eta2=0.01$) in reading accuracy, indicating a consistent gap between the derivational and inflectional word reading across grade levels (See Fig. 1). However, unlike reading accuracy, the interaction of the word type condition by grade level in reading fluency was found to be significant for the typical group of readers ($F(1,207)=27.4$, $p<0.001$, $\eta^2=0.09$) as well as for the poor readers

Table 1 Descriptive statistics of raw scores means and standard deviations and F-values for morphological word type by reader groups
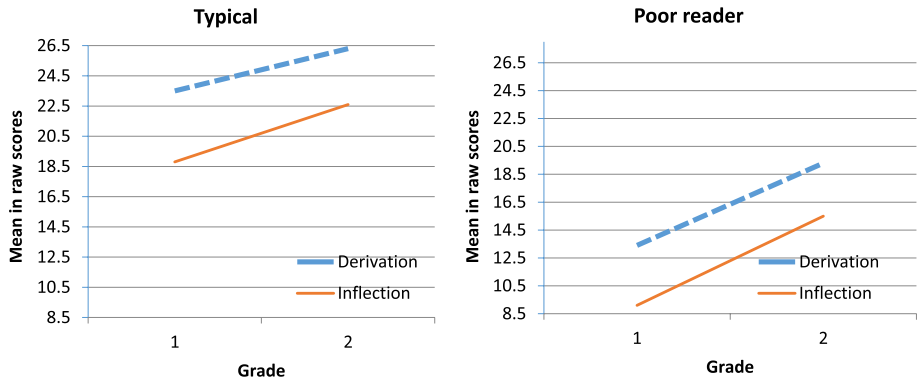
Grade							
	Typical[a]		Poor reader[b]		F(1,455)		
	Derv	Inflc	Derv	Inflc	(η^2)		
	M (SD)	M (SD)	M (SD)	M (SD)	Word type	Reader	Word type* reader
Accuracy							
1[c]	23.5 (5.2)	18.8 (6.3)	13.4 (7.0)	9.1 (6.0)	75.3*** (.09)	316.8*** (.28)	NS
2[d]	26.3 (4.1)	22.6 (4.6)	19.3 (7.2)	15.5 (7.2)			
Overall	24.1 (4.8)	20.7 (5.8)	16.3 (7.6)	12.3 (7.2)			
Fluency							
1	17.0 (9.7)	11.3 (9.9)	5.8 (4.3)	3.2 (2.1)	60.6*** (.07)	173.8*** (.18)	5.9* (.01)
2	28.5 (12.8)	17.4 (7.8)	14.5 (9.9)	8.3 (5.7)			
Overall	22.7 (12.5)	14.5 (9.8)	10.1 (8.7)	5.8 (5.0)			

Derv Derivation, *Inflc* Inflection, *NS* Non-significant

*p < .05. ***p < .001
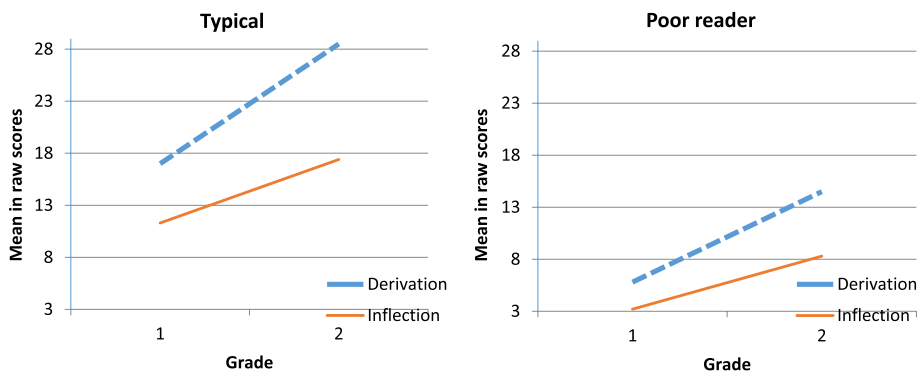
[a]n = 289; [b]n = 112; [c]n = 200; [d]n = 201

Fig. 1 Performance in raw scores for reading accuracy in derivational and inflectional words among typical and poor reader groups by grades

($F(1,207) = 10.8$, $p < 0.01$, $\eta^2 = 0.09$), indicating a larger gap between derivational and inflectional morphology in the advanced grade level (See Fig. 2). Main effects were significant for the word type ($F(1,286) = 260.5$, $p < 0.001$, $\eta 2 = 0.48$) in favor of derivations in typical and poor readers ($F(1,208) = 64.0$, $p < 0.001$, $\eta 2 = 0.37$). A significant effect of the grade level was also observed in both the typical ($F(2,208) = 66.9$, $p < 0.001$, $\eta 2 = 0.19$) and the poor readers ($F(1,208) = 44.5$, $p < 0.001$, $\eta 2 = 0.29$), indicating better fluency performance in the second grade than the first. That is, the results reveal that both group of readers read derivations faster than inflections and showed a significant developmental effect of grade level (see Fig. 2).

Discussion

In the current study, we examined how the morphological structure of words can affect reading performance in Arabic among first and second graders. We compared the reading of words that differ in complexity and the level of morphological transparency. Inflections

Fig. 2 Performance in raw scores for reading fluency (correct items read per minute) in derivational and inflectional words among typical and poor reader groups by grades

consisted of three morphemes (consonantal root, phonological pattern and a suffix), with high transparency of the root morpheme, whereas derivations consisted of two morphemes (a root and a phonological pattern) with lower level of root transparency—e.g., a non-continuous root. Words were matched in familiarity and syllabic length. Findings revealed that three-morpheme words (inflections) were read slower and involved more errors, as opposed to bi-morphemic words (derivations). These differences were found in both examined grade levels and in both groups of readers despite the matching between the word types in root morpheme, syllabic length and familiarity.

Our current findings can be explained in several ways. First, morphological complexity, that is reflected by the number of morphemes, can impact the process of words decomposition and delay word reading. According to dual root models, the composition process is used by the reader to retrieve words' meaning, and is considered very useful in reading complex words. The activation of the decomposition route depends on the unique features of the language and the reader's reading skills (Baayen et al., 1997; Caramazza et al., 1988; Frauenfelder & Schreuder, 1992; Schreuder & Baayen, 1995). Thus, the morphological (and orthographic) complexity of Arabic, as well as the linguistic distance between Spoken and Standard Arabic, might encourage the readers to use such a strategy in reading. That is, as suggested by (Frost , 2012), readers use all available properties to read a word, with morphemes being an important part of this process, in particular when dealing with complex words. That is to say, children use, in parallel to phonological decoding, a morphological decomposition process that further supports word decoding (Saiegh-Haddad, 2018) as early as first and second grade.

Note that although most dual roots models are based on languages with linear morphology, which is considered simpler, the decomposition process is assumed to appear in languages with nonlinear morphology as well. In this case, the word is decomposed into a root and phonological pattern (Boudelaa, 2014; Frost, 2012). In some cases, such as in the inflection system in Arabic, words are formed in both linear and non-linear procedures, containing at least three morphemes: a root that is interwoven into a phonological pattern and an affix that attach to the word. Thus, the decomposition process of such complex forms can be time consuming – a process that is reflected in reading, as has been found in current results. This was found despite differences in the transparency of the root morpheme.

As previously mentioned, both groups of words were constituted from the same root. Yet, the root, which provides the core meaning of the word (Frost et al., 1997, 2000; Vaknin-Nusbaum & Saiegh-Haddad, 2020; Velan et al., 2005), was orthographically highly transparent in inflections, preserving its letter sequence. In derivations, on the other hand, the sequence of the root letters was interrupted by vowel letters interwoven in between. Inflections were read slower despite root transparency, suggesting that morphological complexity might have a crucial effect on the reading process. Moreover, it is possible that since the root is assumed to be mentally represented in semantic languages and serve as a bridge to words' meaning, its transparency level is less meaningful. Readers might easily locate the morpho-orthographic unit of the root, even when vowels are interrupting its sequence.

Another possibility to explain current findings is concealed in the diglossia feature of the Arabic language. According to some researchers (Laks et al., 2019; Saiegh-Haddad & Henkin-Roitfarb, 2014; Saiegh-Haddad & Spolsky, 2014), derivations, that appear in written form in Standard Arabic, are linguistically closer to their counterparts in Spoken Arabic than inflections. Thus, the reading of derivations might be easier due their smaller distance from every day spoken language. However, both groups of words were compared in familiarity according to teachers' rating. Although teacher rating might not be accurate, it

supports the claim that due to a decomposition process, morphological complexity affects reading in novice readers. Such a process takes into account both the number of morphemes and the type of procedure, e.g., linear versus nonlinear. This might also suggest, as postulated by Share (2018), that readers build their morph-orthographic representation along with reading acquisition. Thus, although they are novice readers, they have already developed, to some extent, a storage of morphemes. This assumption is supported by previous research evidence showing that reading fluency (Vaknin-Nusbaum, 2021) and accuracy (Vaknin-Nusbaum & Raveh, 2019) can be improved after participating in an intervention program based on practicing both morphological composition and decomposition procedures of written words. Such a process of morphological decomposition can be critical for Arabic readers, who struggle all along to find ways to bridge the distance between the written and spoken language. As previously suggested, morphological processing supports phonological decoding during the first stages of reading acquisition (Saiegh-Haddad, 2018), and thus has a dominant role in the development of reading in Arabic (Saiegh-Haddad, 2018; Saiegh-Haddad & Taha, 2017; Vaknin-Nusbaum & Saiegh-Haddad, 2020).

The involvement of morphological processing in reading might appear as early as first grade in Semitic languages due to the transparent pointed orthography. Children acquire basic decoding skills early, a process that enables young readers to use morphological cues at an early stage in reading acquisition (Vaknin-Nusbaum et al., 2016, Vaknin-Nusbaum & Saiegh-Haddad, 2020; Saiegh-Haddad, 2018). Diglossia might also push readers to recruit more linguistic information, besides phonological decoding, for the benefit of reading words in standard Arabic. For the above-mentioned reasons, e.g., Arabic morphological complexity, morphological transparency and orthographic depth, the morphological decomposition process might appear earlier in Arabic and in various levels of reading groups, as opposed to other languages.

Indeed, significant differences in fluency between inflection and derivations were found in both the typical and the poor readers as both groups read derivations more fluently than inflections. It is possible that the poor readers who exhibit low performance in phonological decoding try to compensate for this difficulty by using morphological cues. This might suggest that each group of readers uses all morphological tools that are available for the process of decomposition during reading. This enables the readers to look for morpho-orthographic elements of words to retrieve meaning—a time-consuming process in complex words.

Another important difference in reading performance was found between first and second graders. Besides developmental aspects, which suggest reading improvement with grade level, the difference in fluency between inflections and derivation was significantly larger in second graders. That is, with the practice of reading, there seems to be a "jump" in derivational awareness that can be used by children to deal with the challenge of reading in Standard Arabic. Positive progress in derivational awareness can also be reflected in reading fluency. Another possibility is that with the practice of phonological decoding, more resources are available for morphological decomposition, and for expending morpho-orthograpic representation in memory.

In terms of educational conclusions, developing awareness of morpho-orthographic units as part of a reading acquisition curriculum might not only enhance reading fluency, but also improve reading comprehension. This is because new and complex words often appear in written language, and are less frequent in everyday language. Developing awareness of words' linguistic elements can support readers with different reading levels, since, as has been found in this study, both typically developing and poor readers seem to use morphological cues for reading. This might be of great importance for Arab-speaking

readers, who, due to diglossia, might develop reading fluency more slowly than readers in other orthographies (Eviatar & Ibrahim, 2004, 2014).

Although current results provide interesting insights into the role of morphological complexity and transparency in reading acquisition in Arabic, some limitations should be taken into consideration. First, vocabulary—a variable that is linked to morphological awareness and reading performance, was not examined in this study, and should be controlled in a future study. Second, comparing two versus three-morpheme words within the same grammatical group of words, e.g., inflections and derivation, is needed to better understand the morpho-orthographic decomposition process involved in reading. Third, comparing readers in more advanced reading levels in higher elementary school grades might provide insight as to whether current findings are unique to the first stages of reading acquisition.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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