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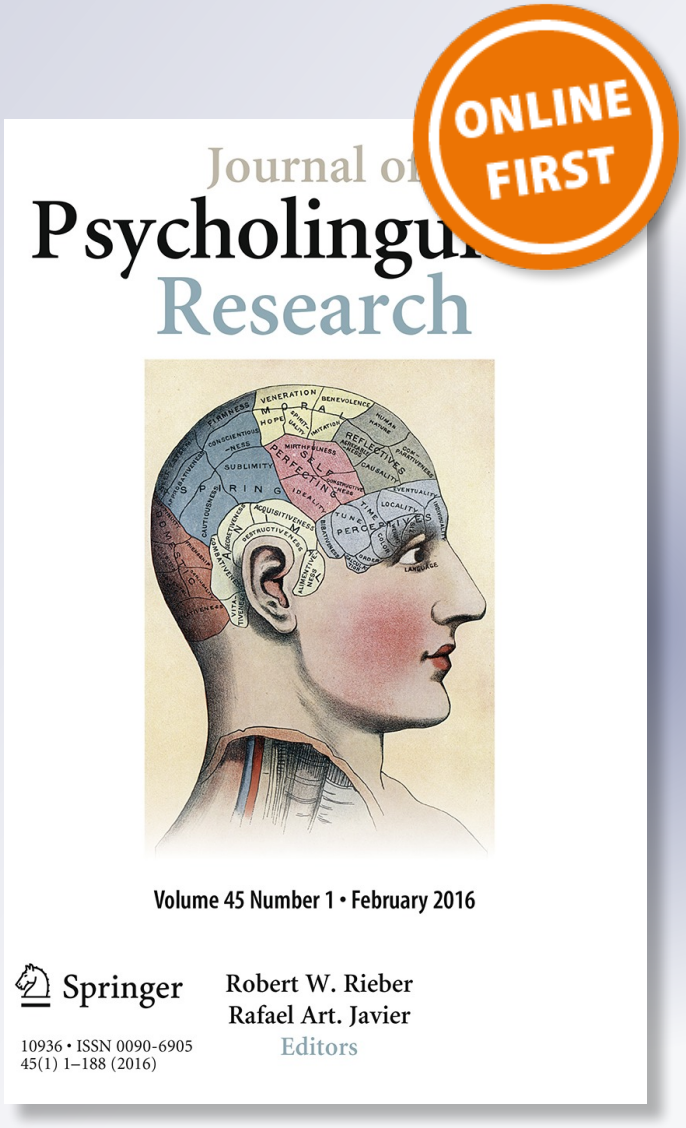

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Morphology and Spelling in Arabic: Development and Interface

Haitham Taha[1,2] · **Elinor Saiegh-Haddad**[3]

Abstract In the current study, two experiments were carried out: the first tested the development of derivational root and word-pattern morphological awareness in Arabic; the second tested morphological processing in Arabic spelling. 143 Arabic native speaking children with normal reading skills in 2nd, 4th and 6th grade participated in the study. The results of the first experiment demonstrated the early emergence of derivational morphological awareness in children, with root awareness emerging earlier than word-pattern awareness. The second experiment supported the implication of morphological processing in spelling words and pseudo words across all grades tested. The results are discussed within a developmental psycholinguistic framework with particular emphasis on the characteristics of the Arabic language and orthography.

Keywords Morphological awareness · Spelling development · Morphological transparency · Arabic orthography · Analogy

Introduction

Recent research has endorsed the role of morphological processing in the acquisition of literacy skills in alphabetic orthographies (Ben-Dror et al. 1995; Levin et al. 2001; Ravid 2001, 2002; Rubin 1991; Saiegh-Haddad and Geva 2008; Sénéchal 2000; Taha 2013; Taha and Saiegh-Haddad 2015; Treiman and Bourassa 2000). This evidence aligns with the finding that morphological structure is implicated in the organization of the mental lexicon and, in turn, that morphological awareness facilitates the storage, retrieval, and recognition of morphologically complex words (Bentin and Feldman 1990; Caramazza et al. 1985). Morphological

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awareness was also shown to contribute to spelling development (Elbro and Arnbak 1996; Ravid and Schiff 2006; Sénéchal et al. 2006). For example, Wolter et al. (2009) found that first grade children employ morphological information to guide their spelling of single words. This is probably due to spellers employing morphological analogy in reading new words. It has also been shown that reliance upon morphological knowledge becomes more efficient as the lexicon of spellers grows and becomes rich with morphologically complex words (Anglin 1993; Nunes et al. 1997; Tsesmeli and Seymour 2006).

All languages make use of morphemes, the smallest units of meaning, in order to construct complex words. In turn, while mapping oral language at the level of the phoneme, alphabetic orthographies represent in fact two layers of structure: the phonemic and the morphemic structure, with cross-linguistic variations lying in the extent to which a given orthography shows loyalty to the *isomorphism principle* (Verhoeven et al. 2003), namely to the morphographic principle, as against the phonographic principle (Perfetti and Harris 2013).

Semitic languages, like Arabic and Hebrew are loyal to the morphographic principle, even when this representation does not align with the word's surface phonological structure (Ravid 2012). This fact drew attention to the role of morphological processing in reading and spelling in these languages, and to cross-linguistic differences in the processing of words in these languages as against non-Semitic languages (e.g., Boudelaa and Marslen-Wilson 2001; Gillis and Ravid 2006; Levin et al. 2001; Saiegh-Haddad and Geva 2008; Schiff 2003; Velan and Frost 2011). This interest was further strengthened by the fact that the large majority of words in these languages are morphologically complex. For example, in a developmental study, Levin et al. (2001), tested children twice at kindergarten and first grade and found a mutual contribution of morphological knowledge and learning to spell in young Hebrew speaking kids.

Morphological Structure and Processing in Arabic

It has been argued that languages get the writing systems they deserve (Halliday 1977). Arabic provides a fine expression of this conjecture in the co-existence of two orthographies: a vowe-leed orthography, which follows the phonographic principle and maps, mainly, the phonemic structure of words, and an unvoweled orthography, which follows the morphographic principle and represents the morphological structure of words. Researchers claim (Saiegh-Haddad and Geva 2008; Saiegh-Haddad and Henkin-Roitfarb 2014) that the unvowelled orthography is only viable in Arabic by virtue of the specific Semitic morphology of the language and in which words have an internal morphological structure. This structure, it is argued, permits the restoration of the missing phonological information marked in the voweled orthography by the diacritical system.

Semitic Arabic is morphologically non-linear or non-concatenative (Larcher 2006; McCarthy 1981) and words in Arabic are, therefore, minimally bi-morphemic comprising two independently unpronounceable bound morphemes: a root and a word-pattern. The tri-consonantal root (e.g., XBZ 'bake', DHN 'paint', ḤLQ 'shave' or 'have a hair-cut', ṬBB 'medicate') provides the core semantic meaning shared by all words within a root-related family of lexical items whereas the word-pattern (e.g., agentive CaCCa:C */xabba:z/* خبّاز 'baker', */dahhan/* دهّان 'painter' and */ħallaq/* حلّاق 'barber') links all word-pattern related lexical items as having the same prosodic structure (e.g., stress, vowels) and a similar categorical meaning and part of speech.

The rich synthetic morphological structure of Arabic is aptly captured by the Arabic writing system, particularly in the unvoweled orthography (Saiegh-Haddad and Henkin-

Roitfarb 2014). The Arabic unvoweled orthography is a consonantal alphabet, or an abjad (Daniels 1992), which is a type of writing system where each symbol always or usually stands for a consonant. This abjad represents, in a fairly transparent manner, the two primary morphological units of word structure in Arabic: the root and the root-pattern.

In this system, all 29 Arabic letters (including hamza which represents the glottal stop consonant and aleph which maps a long vowel) represent the root-radicals and function as root-letters. Thus, the order in which the root letters appears is important in word representation and processing (Velan and Frost 2011) because changing the order of the root-letters produces a new word, or more accurately a new root-related family of words (e.g., MLK 'reign', KLM 'heal', LKM 'punch', KML 'complete').

Besides the root, derivational morphology in Arabic utilizes the word-pattern: verbal and nominal. As a phonological-prosodic entity, the word-pattern captures the phonological structure of the word. Like the root, this structure is also transparently represented yet only at the levels of the constituent consonants and long vowels. The short vowels of the word-pattern, however, are represented only using optional diacritics, which are absent from Arabic in its unvoweled orthography, and are not considered an obligatory part of Arabic spelling. For example: the following words: */madrasah/*مدْرَسَة 'school', */mazraʔah/* مَزْرَعَة 'farm', */maɣsalah/* مَغْسَلَة 'laundry' are derived from the same pattern (*maCCaC-ah* مَفعَلَ-ة). All these words denote locatives (the places where an action takes place: masculine: MCCC */maCCaC/* and feminine MCCCH */maCCaC-ah/*). Although these words carry different meanings, they all share the letters of the word-pattern, the outer-layer in this specific case: {m} at the beginning and {h} at the end, as well as a common categorical meaning and prosodic structure part of which represented by the short vowels represented by the optional diacritics. In addition to the word-pattern letters, which function as constants in all word-pattern-related words, these words also share the slots for the root-letters, the variables in this structure which are the inner-layer and are inserted between the two word-pattern letters.

While the above description implies that the meaning of words may be regularly recovered from its morphological structure, in reality this is not always the case for two reasons: The first is semantic drift with words changing their meanings and producing new meanings not straightforwardly predictable by the root or the word-pattern. The second is the fact that some words are originally loan words that have been integrated into Arabic from other languages and do not, therefore, have a discernible root and word-pattern structure. These words are not as morphologically transparent as other words which employ productive word-patterns and which have a meaning that is predictable by the meaning of the specific word-pattern.

Given the predominance of morphology in the linguistic structure of the Arabic word (Saiegh-Haddad and Henkin-Roitfarb 2014), the transparent representation of morphology in the orthographic structure of the words (Taha 2013; Taha and Saiegh-Haddad 2015), and the centrality of morphology in the organization of the Arabic mental lexicon (Boudelaa 2014), it is expected that Arabic speaking children become aware of the morphological structure of words and use it in word processing in reading and spelling. It is also expected that words constructed using a productive word-pattern will engage morphological processing more than non-productive word-patterns. Research has demonstrated the psycholinguistic reality of the root in the perception and production of Semitic Hebrew (Bentin and Feldman 1990; Berent and Shimron 1997; Berman 1985, 1993, 1999; Clark and Berman 1984; Frost et al. 1997; Ravid and Malenky 2001). Research has also shown that the root and the word-pattern are critical units in the organization of the Arabic lexicon (Boudelaa 2014). Moreover, it was shown that morphological processing is an important correlate of reading and spelling in Semitic languages: Hebrew and Arabic, and is particularly deficient in reading disabled

children (Ben-Dror et al. 1995; Levin et al. 2001). In the context of spelling in Arabic, Saiegh-Haddad (2013) examined the spelling of the letter <t> among 1st grade through 5th grade children. The spelling development of the letter <t> is interesting because this letter may become orthographically irregular (or homographic) due to velarization spread and might as a result encode not only the default voiceless dental-alveolar stop /t/ but also its allophonic variant [ṭ]. Furthermore, this letter participates in the encoding of three productive morphemes: derivational root, derivational word-pattern, and inflectional affix tested. An analysis of the spelling of regular versus irregular <t> as a function of morphological affiliation showed that even young 1st grade children use morphological processing to spell irregular letters in Arabic. The results also showed that there are differences in the degree of morphological processing in spelling as a function of the specific morphological unit targeted with first graders spelling irregular root and affix letters more accurately than irregular word-pattern letters. This finding aligns with developmental research in Hebrew showing that native Hebrew children become aware of root relatedness among words earlier than word-pattern relatedness (Ravid and Bar-On 2001; Ravid and Malenky 2001).

The current study set out to examine two questions: The first is the development of morphological awareness among native Arabic children, specifically the development of derivational root and word-pattern morphological units in normally developing children (Experiment A). The second is to investigate the contribution of the morphological transparency of the written words to spelling accuracy among children with typical reading development (Experiment B). We predict that derivational morphological awareness will emerge early in children, but that root awareness will still develop earlier than word-pattern awareness. We also predict that morphologically transparent words will yield higher word spelling accuracy rates than morphologically opaque words.

Experiment A

The aim of this experiment was to probe the developmental trajectories of root and word-pattern morphological awareness among normally developing Arabic speaking children.

Materials and Methods

Participants

The study tested a total of 143 children with normal reading development in three age-groups: 2nd grade (N = 48), 4th grade (N = 48) and 6th grade (N = 47) who were sampled from 22 Arab schools in the north of Israel. All of the participants were native speakers of the same spoken Arabic vernacular. Participants were chosen based on the following procedure.

In the first step of the screening procedure, a spelling test was administered to all grade-level groups in the purpose of identifying students with spelling difficulties. Spelling difficulties are regarded as a significant predictor of reading disability while other difficulties like emotional, socio-economical and sensory difficulties are excluded (Jiměnez et al. 2003; Fletcher and Denton 2003; Lyon et al. 2002). Accordingly, a spelling test from Abu-Rabia and Taha (2006) was administered in all grades, i.e. in the 2nd ($\alpha = 0.88$), 4th ($\alpha = 0.94$), and 6th grade ($\alpha = 0.82$). *Chronbach* α reliability values are reported in the source study (2006). The students who fell above the 90th percentile according to their performance on the spelling tests were identified as typically developing.

The next step of the selection procedure was testing the reading abilities within the selected group. Two reading tasks were administered: (1) reading a list of words selected from the students' books to ensure that those words are familiar to children in the different grades. Three lists were developed: one for the 2nd grade, the 4th grade and the 6th grade. Each list consisted of 30 words; (2) reading aloud of text: three texts were selected, one per grade-level group. For each group, a number of texts were presented to three teachers of Arabic language from the elementary school in order to judge their suitability to the different grade-level groups. The chosen text was the one that at least two judges agreed was suitable.

A cut point of above 90 % accuracy on both tests was determined to diagnose typical reading ability. In addition, pedagogical, familial and developmental information were gathered about each participant to ensure that the participant did not have any sensory, emotional, or other disturbances.

Tasks and Procedure

Two morphological awareness word-relatedness tasks were used: a) root-based word relatedness and b) word-pattern-based word relatedness. The root-based word relatedness task consisted of 20 items. Each item consisted of a word-pair. 10 word-pairs were root-related (e.g., عامل – معمل 'worker-workshop') and the remaining were semantically related foils (e.g., طبيب – مريض 'doctor—sick'). The participants were presented with each item *orally* and were asked to decide whether the words within each pair were morphologically related and were derived from the same root.

The word-pattern-based word relatedness task consisted of 20 word-pair items. Half of the items were word pairs that shared the same word pattern (e.g., مدرسة–مزرعة- 'school or place of studying- farm or place of farming' while the other pairs were semantically-related foils (e.g., دخان – محروق 'smoke—burnt'). Items in both tasks were presented orally and in a random order. Two practice trails were administered before each task.

Results

Means and standard deviations of performance on the two word-relatedness tasks are provided in Table 1.

Table 1 Means and SD of performance on the root and word-pattern word-relatedness tasks by grade

Grade	Root	Pattern
2nd		
M	88.75	76.66
SD	15.31	18.83
4th		
M	92.50	79.58
SD	15.81	21.92
6th		
M	99.46	99.14
SD	1.87	2.82

Awareness of Root Versus Word-Pattern Relatedness

Analysis of variance (ANOVA) was used to test the effect of type of morphological structure (root and word-pattern) as a between-subject factor on performance on the two word-relatedness tasks. Regarding the root-based word-relatedness task, the results indicated a significant main effect of grade $F(2, 142) = 8.5$, $p < .05$. Tukey post hoc test was conducted to explore the source of the significant differences (see Table 2). The post hoc analysis revealed that there was no significant difference between the second grade (M = 88.75) and the fourth grade (M = 92.50) whereas significant difference was measured between the sixth grade (M = 99.46) and the fourth grade (M = 92.5), and between the sixth grade and the second grade (M = 88.75).

With respect to the word-pattern word-relatedness task, the results indicated a significant main effect of grade $F(2, 142) = 24.9$, $p < .05$. Tukey post hoc test was conducted to explore the source of the significant differences (see Table 2). The post hoc analysis revealed that there was no significant difference between the second grade (M = 76.60) and the fourth grade (M = 79.50). Significant difference was measured between the sixth grade (M = 99.14) and the fourth grade (M = 79.50), and between the sixth grade and the second grade (M = 76.6).

Root Versus Word-Pattern Awareness by Grade-Level

Within each of the grade-level groups tested, a *t* test was used to test for differences between the performances of children on the root-relatedness task versus the word-pattern relatedness

Table 2 Multiple comparisons according to Tukey post hoc test*

Dependent variable	(I) grade of the subject	(J) grade of the subject	Statistics				
			Mean difference (I–J)	Std. error	Sig.	95 % confidence interval	
						Lower bound	Upper bound
Root awareness	2nd	Fourth grade	−3.75	2.6	.32	−9.93	2.44
		Sixth grade	−10.7*	2.6	.00	−16.94	−4.5
	4th	Second grade	3.75	2.6	.32	−2.44	9.94
		Sixth grade	−6.97*	2.6	.02	−13.19	−.75
	6th	Second grade	10.72*	2.6	.00	4.5	16.94
		Fourth grade	6.97*	2.6	.02	.74	13.19
Pattern awareness	2nd	Fourth grade	−2.92	3.4	.67	−11.05	5.22
		Sixth grade	−22.48*	3.45	.000	−30.6	−14.3
	4th	Second grade	2.97	3.43	.673	−5.21	11.05
		Sixth grade	−19.57*	3.45	.000	−27.74	−11.38
	6th	Second grade	22.48*	3.4	.000	14.30	30.66
		Fourth grade	19.57*	3.45	.000	11.38	27.74

* The mean difference is significant at the 0.05 level

task. Significant differences between performance on the two tasks was measured in the second grade, $t(47) = 3.87$, $p < .05$, and the fourth grade, $t(47) = 3.6$, $p = <.05$, but not in the sixth grade $t(46) = 0.62$, $p = 0.56$.

Discussion

The results from experiment "A" explored the developmental trajectories of morphological awareness for the root and the word-pattern among native Arabic speakers. According to the results we obtained, the ability of young native Arab children to deduce root-relatedness between words was superior to their ability to deduce word-pattern relatedness. Moreover, we found that root and word-pattern awareness, while starting out high in children with an average higher than 75 %, it did not develop significantly between the second and fourth graders; the only significant difference was between sixth graders and the other two groups, indicating significant improvement in this ability in the 6th grade. Moreover, we found that while root awareness was consistently higher than word-pattern awareness in both younger grades (2nd and 4th) the difference became insignificant in the 6th grade reaching ceiling levels of performance for both root and word-pattern awareness. The early emergence of derivational morphological awareness, and particularly of the root morpheme is in line with earlier reports of root and word-pattern awareness in Hebrew (Ravid and Bar-On 2001; Ravid and Malenky 2001) and in Arabic (Saiegh-Haddad 2013) and might be attributed to the linguistic properties of roots as against word-patterns. In other words, word-pattern relatedness requires an abstraction of the categorical and morphosyntatic function of the different word-patterns and this appears to be a more difficult and later developing ability than the ability to link words related by the root, a salient semantic entity linking words by meaning rather than by syntactic properties (Saiegh-Haddad 2013; Saiegh-Haddad and Henkin-Roitfarb 2014). Moreover, roots are fully represented in the Arabic orthography while word-patterns are only partially represented; only the consonants and long vowels of word-patterns are represented in the orthographic system of the default unvoweled Arabic orthography. This makes the root an orthographically salient unit.

The results also show that the development of derivational morphological awareness in Arabic has a rather long developmental trajectory, yet shorted than that reported for other languages like English, and is not fully mastered in the early stages of literacy acquisition but it continues to develop throughout the elementary school grades and until the sixth grade. This finding has been reported in the literature. As is well known, one of the main factors that affect the development of derivational morphological awareness is exposure to print and the size of the orthographic and linguistic lexicon (Anglin 1993; Tsesmeli and Seymour 2006; Tyler and Nagy 1989). Accordingly, it grows with age and grade-level as this study has shown.

Experiment B

In this experiment, we tested whether children use morphological processing in spelling. If so, we predicted that the spelling accuracy of words and pseudo words that are morphologically transparent would be higher than that for morphologically opaque words. This is because morphological clues enhance spelling by triggering morphological analogies (Gillis and Ravid 2006; Ravid and Schiff 2006; Sénéchal et al. 2006). The participants in this experiment were the same children participating in Experiment "A".

Table 3 Means and standard deviations of word and pseudo word spelling accuracy by morphological transparency and grade

Grade	Spelling of transparent-morphological words	Spelling of opaque words	Spelling of transparent-morphological pseudowords	Spelling of opaque pseudowords
2nd (n = 48)	50	19.58	39.16	10.3
	(23.6)	(11.47)	(15.8)	(6.2)
4th (n = 48)	64.16	28.8	63.54	13
	(21.52)	(16.5)	(23.38)	(9.23)
6th (n = 47)	75	41.25	68	25.41
	(20.1)	(23.59)	(22.3)	(20.23)

Materials and Procedure

Spelling Real Words

In this task, each participant was asked to spell 30 dictated real words. Half of the words were morphologically transparent employing a productive word-pattern and a frequent root (e.g., إستعمل / *ʔista ʕmal*/ 'used' from the word-pattern ʔistaCCaC and the root ʕML), while the remaining words had a non-transparent morphological structure in which neither a root nor a productive word-pattern is discernible (e.g., طربوش /ṭrabu:š/ 'a traditional hat' or استاذ/ʔusta:ð/ 'teacher'). Our assumption was that transparent morphological patterns contain transparent morpho-orthographic clues. This can enhance spelling by inducing morphological and morpho-orthographic processing. Such clues are in our case the letters representing the root and word-pattern morphemes. Transparent and opaque words were presented in a random order.

Spelling Pseudo Words

In this task, each participant was asked to spell 30 dictated pseudo words. Half of the pseudo had a transparent morphological pattern. That is they were derived from productive word-patterns using pseudo roots (e.g., استبلَجَ which is derived from the verbal word pattern ʔistaCCaC and the pseudo root BLJ), while the remaining pseudo words had a non-transparent morphological structure in which no real root or word pattern may be identified (بَرافِم /bara:fim/). Our assumption was that the pseudo words with a transparent morphological structure would yield higher accuracy rates due to the fact that they offer morphological cues and may induce morpho-orthographic processing. Transparent and non-transparent words were presented in a random order.

Results

Table 3 presents means and standard deviation for performance on the real and pseudo word spelling tasks by grade and morphological transparency (transparent versus opaque).

We used analysis of variance to test the effect of grade as a between subject variable on the two sets of transparent and opaque words and pseudo words. The results revealed a significant main effect of grade for the spelling of both types of words: transparent, $F(2, 142) = 16.2$, $p < .001$, and opaque words, $F(2, 142) = 28.94$, $p < .001$, and both types of pseudo words: transparent, $F(2, 142) = 8.16$, $p < .05$, and opaque pseudo words $F(2, 142) = 23.94$, $p < .05$.

The results were then analyzed for each grade-level separately. Within each group, the differences between the spelling means of the transparent and the opaque items were analyzed using *t* tests for paired samples. The results revealed significant differences in spelling accuracy between transparent words and opaque words in all grades: 2nd grade: $t(47) = 9.21$, $p < .05$; 4th grade: $t(47) = 13.19$, $p < .05$; and 6th grade: $t(46) = 8.03$, $p < .05$. The results also showed significant differences in spelling accuracy between transparent and opaque pseudo words in all grades: 2nd: $t(47) = 11.68$, $p < .05$; 4th: $t(47) = 16.44$, $p < .05$, and 6th: $t(46) = 12.53$, $p < .05$.

Discussion

The results of experiment "B" support the implication of morphological processing in the spelling of real and pseudo words among young Arabic spellers supporting earlier reports (Saiegh-Haddad 2013). The results showed that real and pseudo words were spelt more accurately when they were constructed according to a transparent morphological structure and employed productive word-patterns than when they were opaque. Moreover, the results indicated that this was the case among both young and older kids implying the implication of morphological processing in spelling even among children in the late elementary grades, and despite the fact that the orthography is shallow. The relevance of morphological processing even in the spelling of shallow orthography Arabic may be attributed to diglossia. Many of the words that are regularly and reliably represented in the Arabic orthography have forms in spoken Arabic that vary from their standard Arabic form, the one encoded in spelling. These words are referred to as cognates and they make up about 40 % of the words in the lexicon of children (Saiegh-Haddad and Henkin-Roitfarb 2014). Phonological differences between the form of the word in spoken and standard Arabic might affect spelling accuracy negatively because of interference from the spoken speech-based phonological representation of the word. The use of the morphological word pattern to recover the standard Arabic phonological form might be particularly important in such instances especially as the word-pattern captures the phonological structure of the word. For instance the word مكاتيب /maka:ti:b/ 'letters' derives from the word-pattern maCa:Ci:C and the root KTB. This word is pronounced /makati:b/ in spoken Arabic because of vowel reduction in this specific phonological environment. Use of the word-pattern of the word will alert the speller to the letter aleph and which is likely to be missed if the reader relies only on grapheme-phoneme correspondence rules and on the pronunciation of the word in spoken Arabic. In the same way, accurate spelling of unique standard words which are not used in spoken Arabic at all requires high-quality phonological representation. Given the phonological and lexical distance between spoken Arabic and standard Arabic, morphological awareness and morphological processing should enhance the phonological encoding and storage of the word in working memory (Saiegh-Haddad 2003, 2004, 2007; Saiegh-Haddad et al. 2011) and hence their accurate translation into an orthographic form.

General Discussion

Research has shown that children's developing spelling ability may shed light on their linguistic knowledge and linguistic processing mechanisms. This is because (1) writing systems reflect the typological architecture of the languages they represent (Frost 2012; Ravid 2012), and (2) learning to read and spell accommodates the demands of the different writing systems (Perfetti et al. 2013). The current study demonstrates the early emergence of derivational morphological awareness in young Arabic speaking children. Furthermore, they show the early implication of derivational morphological processing in spelling in Arabic. These findings have valuable educational and pedagogical implications. Specifically, we found that root and word-pattern awareness is evident in young second graders and it continues to develop across the elementary school grades showing an abrupt increase in the 6th grade. Furthermore, even young second graders use the morphological structure of the word in spelling real and pseudo words. These finding, while supporting earlier reports in Hebrew (Ravid and Bar-On 2001; Ravid and Malenky 2001; Ravid and Schiff 2006) and Arabic (Saiegh-Haddad 2013; Taha and Saiegh-Haddad 2015) are not in accordance with the results reported for English speakers where derivational morphological awareness and processing appears to be a late developing ability (Arnbak and Elbro 2000; Carlisle 2000; Sénéchal et al. 2006). We argue that these differences reflect cross-linguistic differences in the predominance of derivational morphology in the linguistic and orthographic structure of English words as compared with words in Semitic Arabic (Saiegh-Haddad and Geva 2008; Saiegh-Haddad and Henkin-Roitfarb 2014).

The results of the current study also imply that the role of morphological processing in spelling in Arabic may be particularly important in light of Arabic diglossia and the remarkable phonological differences between the forms of words in spoken and standard Arabic (Saiegh-Haddad and Spolsky 2014). In other words, the morphological structure of the standard Arabic word may be used to recover its phonological structure and this becomes critical when the word has a form in standard Arabic that overlaps only partially with its form in the spoken vernacular of Arabic speakers. Future research should test this hypothesis directly by investigating the spelling of different types of transparent and opaque words, such as identical, cognate and unique words (Saiegh-Haddad and Henkin-Roitfarb 2014). In modeling reading in Arabic, Saiegh-Haddad (in press) argues that morphological structure and diglossia are two key features to understanding reading development and processing in Arabic. This may also be true for spelling development yet more research is still warranted.

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