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How simple is reading in Arabic? A cross-sectional investigation of reading comprehension from first to sixth grade

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This study aimed to examine, from a cross-sectional perspective, the extent to which the simple view of reading (SVR) model can be adapted to the Arabic language. This was carried out by verifying, in both beginning and more skilled readers, whether the unique orthographical and morphological characteristics of Arabic contribute to reading comprehension beyond decoding and listening comprehension abilities. Reading comprehension was evaluated in a large sample of first to sixth-grade Arabic-speaking children. The participants' decoding and listening comprehension abilities were investigated together with their orthographic and morphological knowledge. Path analysis indicated that reading comprehension was moderately explained by the SVR (56–38%). Orthographic and morphological knowledge explained an additional 10–22% of the variance beyond that explained by the basic SVR components. These findings demonstrate that certain linguistic aspects of Arabic impact reading processes differently when compared with other languages. The psycholinguistic implications of these findings are discussed in the light of previous findings in the literature.

What is already known about this topic?

- The 'simple view of reading' model explains reading comprehension as the product of decoding and listening comprehension.

- This model explains between 70% and 83% of the variance in reading comprehension in English, in which the contribution of decoding and listening comprehension varies as a function of the level of the readers.
- Orthographic transparency and other unique characteristics of the languages studied might influence reading comprehension in these languages

What does this paper add?

- Arabic is a diglossic language that is characterised by relatively unique orthographic and morphological features for which the validity of the simple view of reading (SVR) has not been tested.
- The basic components of the SVR (decoding and listening comprehension) have explained between 56% and 38% of the variance in reading comprehension in children from the first to the sixth grade.
- Decoding, as one of the basic components of the SVR, failed to contribute to reading comprehension when orthography and morphology were considered.

Implications for practice and/or policy

- This large-scale cross-sectional study is the first of its type to assess reading comprehension in Arabic.
- The study justifies the necessity to assess the suitability of the SVR in languages with very specific linguistic characteristics such as Arabic.
- The results emphasise the necessity of considering the complex orthography and the rich morphology of Arabic for improving teaching, assessment and intervention.

The development of reading comprehension, as the ultimate goal of reading acquisition, has attracted many researchers in various languages. In this context, one of the most prevalent theories is the 'simple view of reading' (SVR) model, which was first proposed in English by Gough and Tunmer (1986) and by Hoover and Gough (1990). This model posits that reading comprehension can be explained as the product of decoding abilities and listening comprehension. Listening comprehension is typically assessed by using questions about an orally presented text. Decoding refers to the process of translating printed words into speech and is usually assessed by using pseudowords (Hoover & Gough, 1990; Joshi & Aaron, 2000). Additionally, it was emphasised that both decoding and listening comprehension were necessary for reading comprehension but that neither was sufficient alone (Gough & Tunmer, 1986).

Supporters of the SVR in English claim that these two main and dissociated components include many other reading subcomponents (Hoover & Tunmer, 1993) and that their influence varies with the different phases of reading acquisition (Chen & Vellutino, 1997; Florit & Cain, 2011). The contribution of decoding is reported to be stronger in beginning readers and tends to decrease as readers become more skilled (Duke et al., 2004), whereas the contribution of listening comprehension tends to increase (Catts et al., 2005; Chen & Vellutino, 1997). Some authors suggested that this model should be extended to include other factors that influence reading comprehension (Joshi & Aaron, 2000; Kirby & Savage, 2008). The componential model of reading, for instance, is considered an extended version of the SVR model (Joshi & Aaron, 2000) and proposes taking into account the contribution of not only other linguistic and cognitive factors but also environmental and psychological variables (Aaron et al., 2008; Katzir et al., 2009).

The validity of the SVR has been widely replicated in English orthography where the original model was developed, but some researchers have questioned its power to predict reading comprehension in other languages (Chen & Vellutino, 1997). Currently, findings from other languages and orthographies suggest that while the SVR is adequate, on the whole, in explaining reading comprehension, different patterns of correlations could be found between its components, due mainly to the depth of the various orthographic systems (Florit & Cain, 2011). Decoding seems to be a stronger predictor in opaque orthographies, whereas oral language skills explain more variance in reading comprehension in transparent orthographies. A recent study (Joshi et al., 2012) that compared the SVR in Spanish (as a transparent orthography) and in Chinese and English (as opaque orthographies) found that the model explained more variance in reading comprehension in Spanish (~60%) than in English (~50%) and explained more variance in both of these than in Chinese (between 25% and 42%). Additionally, it was reported that decoding explained less variance in Spanish than in Chinese or English. These authors concluded that orthographic transparency plays an important role in the prediction of reading comprehension. Consistent with this conclusion, the meta-analysis published by Florit and Cain (2011) indicated that, in comparison with deep orthographies, linguistic comprehension in transparent orthographies is a more important predictor of reading comprehension than decoding, even for beginner readers.

Acquiring reading in deep/opaque orthographies is thought to be more challenging than in transparent ones (Seymour et al., 2003; Ziegler & Goswami, 2005). The ambiguity of the grapho-phonemic relations in deep orthographies makes decoding a process that develops more slowly, and thus its contribution to reading comprehension is longer lasting. The consistency of the grapho-phonemic relations in transparent orthographies allows for a rapid and easy development of decoding skills (for accurate and efficient reading) by the end of children's first grade, explaining the rapid decrease in its contribution to reading comprehension (Landi, 2010; Leppänen et al., 2008).

In Semitic languages, the first findings from Hebrew (Primor et al., 2011) showed that the SVR explained between 25% and 34% of the variance in children in the fourth grade. This latter study showed that while orthographic knowledge contributed significantly to reading comprehension, both in normal and disabled readers, morphological knowledge contributed only in the reading disabled group. These results indicated that additional components are necessary for reading comprehension in this Semitic language. In a more recent study conducted with second to tenth-grade children in Hebrew (Joshi et al., 2015), the SVR explained between 37% and 70% of the variance, and the contribution of orthographic knowledge was significant in all grades.

In Arabic, the other Semitic language that shares similarities with Hebrew but has several linguistic particularities that are hypothesised to seriously affect literacy processes (Abu-Rabia, 1999, 2002; Ibrahim et al., 2002; Mahfoudhi et al., 2011; Saiegh-Haddad, 2003, 2004, 2007; Saiegh-Haddad & Henkin-Roitfarb, 2014), the validity of the SVR has not yet been examined. Hence, this study aimed to assess to what extent the SVR explains reading comprehension in Arabic among elementary school children.

Specificities of the Arabic language

Arabic is a diglossic language (Ferguson, 1959) in which two different varieties of the language are used for different purposes: spoken and literary Arabic (the latter is also

referred to as 'Modern Standard Arabic', see Saiegh-Haddad & Joshi, 2014). The differences between spoken and literary Arabic appear in various aspects of the language, including at the phonological, morphological, semantic and syntactic levels (see, for review, Saiegh-Haddad & Henkin-Roitfarb, 2014). These differences, in particular at the level of the core components (lexical and sublexical) of literary Arabic, present certain challenges that affect language development itself and reading acquisition and comprehension more specifically (Saiegh-Haddad, 2003, 2004, 2007). Regarding the patterns of use of spoken and literary Arabic, children first use spoken Arabic only (i.e. their mother tongue) for purposes of oral communication during the preschool period (~5–6 years). Subsequently, they begin acquiring literary Arabic through formal instruction in reading and writing. Of note is the fact that the use of standard literary Arabic for speaking during lessons/instruction hours at school is not systematic at all (except in Arabic language and religion instruction lessons). Regarding language instruction per se, this process generally follows official curricula in which the literary standard vocabulary is slowly but gradually acquired from the first grade together with simple morphological and syntactic knowledge. A recent review by Al Ghanem and Kearns (2015) indicated that the official reading acquisition curricula in several Arab countries put a strong emphasis on orthographic skills, with less emphasis on phonological skills and very little on the morphological features of the words.

The Arabic orthographic system is considered a complex one where challenges in basic perceptual discrimination of letters may significantly affect acquisition of literacy processes (Ibrahim et al., 2002; Saiegh-Haddad & Henkin-Roitfarb, 2014), the speed of word recognition (Abdelhadi et al., 2011; Khateb, Khateb-Abdelgani, Taha, & Ibrahim, 2014) and consequently, reading comprehension. Arabic orthography is characterised by a certain visual density and a great visual similarity between letters. The system comprises 29 consonant letters, of which three also represent long vowels. Arabic letters belong to dyads or triads, in which the letters share the same basic form but differ in minor features represented by the presence or the absence of dots, by the position of these dots (under or above the letter) and by their number (Holes, 2004; Saiegh-Haddad & Henkin-Roitfarb, 2014). Short vowels (i.e. when the script is vowelised) provide the necessary phonological information needed for the accurate decoding of the written words. These short vowels are represented by diacritical marks appearing above or below the letters, in which case the orthography is considered transparent. In the beginning of the process of reading acquisition, children learn to read with the vowelised (transparent) orthographic version. At around the fourth grade, children move progressively to reading unvowelised Arabic texts, and then the orthography is considered to be opaque or deep. In this case, the phonological information is partly unavailable because words are presented with consonants and long vowels only, and many words become homographic (Abu-Rabia, 2001).

The Arabic morphological system is considered rich and dense. Some authors maintain that morphological units in Arabic are an integral part of the orthographic knowledge (Taha & Saiegh-Haddad, 2016). Additionally, there is some evidence that indicates that morphology in Arabic is one of the organisational principles of the mental lexicon and that morphology significantly contributes to the words' visual recognition processes (Boudelaa & Marslen-Wilson, 2001, 2005, 2011). In fact, words in Arabic are produced from the combination of roots representing the meaning of the word and patterns that determine their lexical and syntactical categories (see Saiegh-Haddad, 2013; Saiegh-Haddad & Henkin-Roitfarb, 2014). A majority of the words in Arabic are produced through inflectional processes on the roots and patterns and derivational processes on the roots.

The words can include a number of morphemes, making them morphologically complex in the sense that one single Arabic word might correspond to one complete sentence in English. For instance the word <سنذهب> /sanađhab/ which comes from the root <ذهب> /đhb/, corresponds in English to the sentence '*we will go*'. In this example, the root is affixed by the morphemes <س/ن> /s, n/, with the first determining the tense of the verb (<س> /s/, for the future) and the second representing the personal pronoun (<ن> /n/, for '*we*') that determines the number and person of the subject. In early research, it was suggested that morphological density decelerates the reading rate because readers are required to perform segmentation (Shimron & Sivan, 1994). More recent research indicates that the morphological richness of Arabic (and Hebrew) enhances reading and spelling (e.g. Ravid, 2012; Saiegh-Haddad, 2013). In particular, authors claim that the internal morphological structure of unvowelised Arabic words permits the restoration of the missing (which is otherwise present in the vowelised orthography) phonological information (Abu-Rabia, 2007; Saiegh-Haddad, 2013; Saiegh-Haddad & Geva, 2008). The authors further argue that the unvowelised orthography is viable only in Arabic because of the specific Semitic morphology of the language, an argument that, to a great extent, also holds for reading in unpointed/unvowelised Hebrew (Bar-On & Ravid, 2011).

In view of the diglossic situation of Arabic and of the particular characteristics of its orthographic and morphological systems, one can assume that the way in which listening comprehension and decoding contribute to reading comprehension might be different in this language. This assumption is based on the fact that listening comprehension relies primarily on oral language which, in the case of diglossic Arabic speakers, is significantly affected by the spoken dialect. In addition, decoding abilities might behave differently because of the complexity and the particularities of the writing system. Up to now, the existing research on reading comprehension has not yet dealt with the question of the validity of the SVR in Arabic. Accordingly, this research aimed to address the following questions:

1. How do decoding and listening comprehension predict reading comprehension in Arabic transparent orthography in elementary school children?
2. How do the unique orthographic and morphological characteristics of Arabic explain reading comprehension beyond decoding and listening comprehension?

On the basis of previous research on other languages and particularly on Hebrew, we hypothesised that the main components of SVR will predict reading comprehension and that they will explain more variance in beginning readers than in more skilled readers. We also predicted that, due to the uniqueness of the Arabic writing system, orthographic knowledge will contribute to reading comprehension beyond the specific contribution of decoding and listening comprehension. Concerning morphology, we predicted that its influence will be marginal, given that all the texts were presented in a vowelised transparent script in which the phonological information is available to the readers.

Material and methods

Participants

A total of 1,385 (619 of whom were boys) native Arabic-speaking pupils were recruited for this study in the context of a nationally representative sample. This included (i) 115

first graders, (ii) 253 second graders, (iii) 252 third graders, (iv) 255 fourth graders, (v) 256 fifth graders and (vi) 254 sixth graders (see details in Table 1). The sampling was conducted in three stages. In the first stage, 23 Arabic-speaking schools were sampled from all the Israeli districts (including the Arab, Druze and Bedouin populations). This first selection stage, conducted by the Israeli Ministry of Education, took into consideration the socioeconomic status of the schools in order to represent low, medium and high socioeconomic status levels. These levels are determined by the ministry on the basis of the parents' income and occupation and the ranking of the family's residential area. In the second stage, also conducted by the ministry, the sampling of one class for each grade level was randomly undertaken in each of the 23 sampled schools. In the third stage, conducted by the researchers, the participants (from these classes) were sampled by taking each third child from an alphabetical list of names for each grade (unless that child was formally diagnosed with learning/mental disabilities). For each grade level, this selection provided approximately 11 children from each class from each of the 23 sampled schools, yielding a total of approximately 253 participants in each grade (except for first grade due to time constraints at the end of the academic year, Table 1).

Material

The tools used in this study included measures for assessing reading comprehension, decoding abilities, listening comprehension and orthographic and morphological knowledge. All the tests were developed for the purpose of the present research on the basis of a pilot study conducted with 60 children from each grade, who were sampled from 10 schools in different districts in Israel. This pilot study allowed the selection of the test items as a function of the level of difficulty for each grade on the basis of rigorous assessments made by teachers and linguistic consultants. The choice of the items for the various tests was based on the guidelines of the Israeli Ministry of Education, which recommended the skill level to be attained in the different grades and the rules for evaluating their acquisition. Based on the results of the pilot study, items showing ceiling or floor effects were excluded. An assessment of the children's familiarity with the words was performed by teachers, and items with medium familiarity (i.e. between 2.5 and 3.5 on a 1 to 5-point scale) were retained. To establish tests that were developmentally appropriate, the reliability of all the tests constructed was determined (see succeeding texts for the Cronbach's alpha for each test). Moreover, to determine the developmental changes between two successive grades, some of the tools were common for the first and second, the third and

Table 1. Details of the participant groups.

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
N participants (%)	115 (8%)	253 (18%)	252 (18%)	255 (19%)	256 (19%)	254 (18%)
Mean age[a] (*SD*)	82 (4.6)	94 (4.6)	105 (4.1)	116 (4.8)	129 (3.9)	140 (3.8)
N boys (%)	51 (44%)	131 (52%)	121 (48%)	112 (44%)	93 (36%)	111 (44%)
N girls (%)	64 (56%)	122 (48%)	131 (52%)	143 (56%)	163 (64%)	143 (56%)

Note:
[a]Mean age in months.

fourth and the fifth and sixth grades (see details in the succeeding texts and examples in Appendix 1).

Reading comprehension. On the basis of previous studies showing that vowelisation facilitated reading comprehension both in beginning and skilled readers (Abu-Rabia, 1999), and to minimise the interference of decoding processes on reading comprehension, we used only vowelised texts to assess reading comprehension. For the purpose of the study, six vowelised texts were created and adapted to the different grade levels. The texts for the first to fourth grades were narrative ones, whereas those for the fifth and sixth grades were expository. In each grade (except for the first), the participant dealt with two texts: (A) a text from the grade in the succeeding texts and (B) a grade-adapted text. For the first grade, together with the text, 20 items were also developed and included figures and sentences to better assess reading comprehension. Each of these items comprised a picture presented with two sentences, and the participant was asked to decide which sentence corresponded to the picture. For the texts, the participants in each grade were first required to silently read text A (the text of the grade in the succeeding texts), then, after answering the relevant multiple choice questions, they continued to text B (i.e. the grade-adapted text). The texts for the second to sixth grade contained between 28 and 32 questions, whereas the text for the first grade contained 20 questions. The participant's score was based on the total number of correct answers in the two texts (and the text and figures in the first grade). The reliability of the reading comprehension tests (Cronbach's α) ranged from .81 to .90 in the different grades.

Decoding. Because unvowelised pseudowords can generally be read in different ways (as homographs in actual words), we used only vowelised items in order to mainly assess the accuracy of the participants' decoding skills. Four lists of pseudowords, adapted in terms of list length to each grade level, were compiled. Two lists were compiled for the first and second grades, one list for the third and fourth grades and the last list for the fifth and sixth grades. The lists contained between 20 and 25 items for the first to the sixth grades. The pseudowords were constructed based on the phonological structure of real words and represented several morphological patterns in Arabic. The length of the words ranged from one to four syllables. The participants were required to correctly read aloud the pseudowords, which were presented in an increasing order of difficulty (see examples in Appendix 1). A participant's score was based on the total number of correctly read items. The reliability of the test (Cronbach's α) ranged from .92 to .93 in the different grades.

Listening comprehension. Twenty-five sentences were created for the first and second grades, and two listening comprehension texts were designed separately to test the children in the third and fourth grades and fifth and sixth grades. The sentences contained between 6 and 12 words that were read by an examiner. The participants were required to answer 25 multiple-choice questions. The text for the third and fourth grades was composed of 83 words and involved 18 questions, whereas the text for the fifth and sixth grades was composed of 163 words and included 19 questions. In both cases, the participants, immediately after the examiner had read the text twice, were required to answer multiple-choice questions that were also read by the examiner. Each participant's score was based on the total number of correctly answered questions. The reliability of this test (Cronbach's α) ranged from .70 to .83 in the different grades.

Orthographic knowledge. The assessment of orthographic knowledge was conducted by using the two following orthographic tests:

1. *Parsing*: This test examined the ability to identify orthographically significant patterns (i.e. to detect word boundaries) inside a sequence of letter strings that were presented in a line without spaces between them. The test developed for all grades included 46 line items. Each item (i.e. sequence of letters) contained four separate words that did not constitute a meaningful sentence. The selected words ranged from one to five syllables, and they represented a variety of nouns and verbs from different morphological patterns. Each examinee was asked to separate the words by drawing a line between two successive words (see examples in Appendix 1). The participant received one point for each item (four words) correctly identified. The reliability of this test (Cronbach's α) ranged from .80 to .91 in the different grades.
2. *Orthographic choice*: This test was designed to examine the ability to review orthographic patterns and to identify the wrong ones. Three lists were compiled: a list of 40 items for the first and second grades, a list of 60 items for the third and fourth grades and a list of 100 items for the fifth and sixth grades. The items represented a variety of nouns and verbs from different morphological patterns in correct and incorrect forms. The words ranged from one to four syllables, and the incorrect forms represented the most common phonological mistakes generally induced by emphatic sounds. During the test, the examinee was asked to identify the correct and incorrect forms and to mark the incorrect forms (see examples in Appendix 1). The participant received one point for each marked incorrect item and each ignored correct item. The reliability of this test (Cronbach's α) ranged from .83 to .91 in the different grades.

Morphological knowledge. The evaluation of morphological knowledge was undertaken by using the four following tests:

1. *Inflecting verbs and nouns*: This test examined the ability to inflect verbs and nouns in the literary (modern standard Arabic) language. Three test lists were compiled: a 19-item list for the first and second grades, a 24-item list for the third and fourth grades and a 23-item list for the fifth and sixth grades. For the verbs, the participant was required to inflect the root according to person and number (singular or plural), gender and tense. For the nouns, the examinee was required to inflect the noun according to gender and number (using only possessive pronouns). For this latter section, the participant was presented with a picture depicting objects and people that indicated gender and number and was asked to say the word describing the object belonging to the person/s, while taking into account the gender and number (see examples in Appendix 1). The participant received one point for each correct item. The reliability of this test (Cronbach's α) ranged from .88 to .91 in the different grades.
2. *Derivation of words in context*: This test examined the ability to derive from a given root the word that completes a sentence. Three lists were compiled: for first and second grades (14 items), third and fourth (16 items) and fifth and sixth grades (16 items). During the test, the examinee heard an incomplete sentence and was required to complete it according to a given root (see examples in Appendix 1). The participant received one point for each correct item. The reliability of this test (Cronbach's α) ranged from .60 to .62 in the different grades.

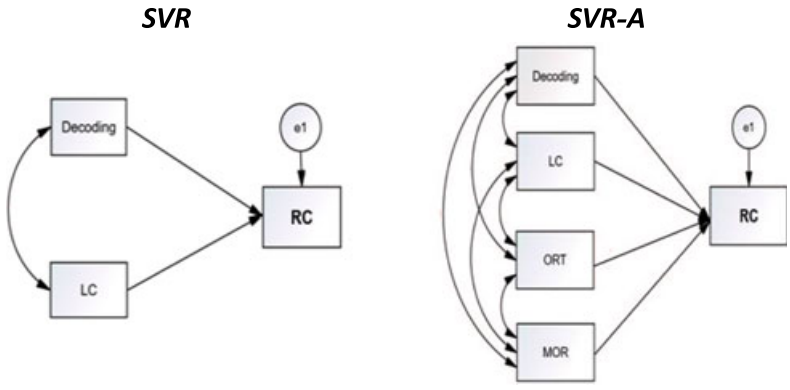
3. *Root awareness*: This test examined the children's awareness of the root of words. Three lists were compiled: a list of 22 items for the first and second grades, a list of 28 items for the third and fourth grades and a list of 30 items for the fifth and sixth grades. In each item, four words were presented and read to the participant, who was required to designate the item that did not relate to the same root 'family' (i.e. did not derive from the same root; see examples in Appendix 1). The participant's score was based on the number of correct answers. The reliability of this test (Cronbach's α) ranged from .82 to .91 in the different grades.
4. *Pattern awareness*: This test examined the children's awareness of morphological patterns existing in Arabic. Three lists were compiled: a list of 19 items for the first and second grades, a list of 18 items for the third and fourth grades and a list of 21 items for the fifth and sixth grades. The items represented a variety of morphological verb patterns. In each item, two words were presented and read to the examinee who was required to decide whether the words were related to the same pattern (see examples in Appendix 1). The participant scored one point for each correct answer. The reliability of this test (Cronbach's α) ranged from .72 to .81 in the different grades.

Procedure

The participants were individually tested during school hours, and the testing took place in a quiet schoolroom. All the examiners were professionals in special education, communication disorders and learning disabilities who had received specific training from the researcher; he had instructed them about the procedures for the administration of the tasks. For all the groups, the study was conducted in the third part of the school year (between March and May). To minimise any possible effect of order, the different tasks were administered to the children in different orders. Moreover, for the purpose of further validating the results and to verify the reliability of the information obtained from the children, the teachers filled in a questionnaire on the participants' reading abilities. This measure was found to correlate significantly with the participants' scores in decoding ($r = .50$, $p < .01$) and reading comprehension ($r = .57$, $p < .01$).

Statistical analyses

For the linguistic domains examined by using two or more tests, a general measure (index) for the domain was created after the computation of a coefficient of correlation (i.e. when there were two tests) or a coefficient of reliability (Cronbach's α when more than two tests were used). Based either on a significant correlation or on the reliability measure, average performance on the different tests was computed. Thus, for reading comprehension, a large correlation between the two texts was found ($r = .66$, $p < .001$). Similarly, for orthographic knowledge, the correlation between the parsing and orthographic choice tests was large ($r = .50$, $p < .001$). For morphological knowledge, the result of the Cronbach's α reliability test was $\alpha = .77$. To determine the contribution of the different measures to reading comprehension, path (saturated) models (Figure 1) were computed separately for each grade by using AMOS 18.0 software (Arbuckle, 2009). This model is identical to linear regression analysis and gives the same results in terms of standardised coefficients (β) and % explained variance (R^2).



Note: DEC: Decoding; LC: Listening Comprehension; ORT: Orthographic knowledge; MOR: Morphological knowledge; SVR: Simple View of Reading; SVR-A: Simple View of Reading for Arabic.

Figure 1. Schematic representations of the path models.

Results

To verify to what extent the two basic components of the SVR are dissociated, a factor analysis was conducted by using Varimax rotation. As presented in Table 2, this analysis yielded two factors. The first explained 51.7% of the variance and comprised decoding, orthographic and morphological knowledge with an eigenvalue of 2.59. The second factor comprised listening and reading comprehension skills and explained 26.7% of the variance with an eigenvalue of 1.34. A small ($r = .292$) but significant correlation ($p < 0.01$) was found between the two factors.

The descriptive statistics of the participants' scores and the correlation between the different measures are presented by grade in Table 3. The mean (in % and standard deviation) performance across the participants in each measure and each grade demonstrates noticeable developmental changes between the two successive grades (first and second, third and fourth and fifth and sixth), which were examined very frequently using the same tasks (see, in particular, the mean scores of listening comprehension, orthography and

Table 2. The results of the factor analysis.

Measures	Factor I loading	Factor II loading
ORT	0.923	−0.170
MOR	0.860	0.313
DEC	0.725	0.381
LC	0.073	0.870
RC	0.167	0.863
Eigenvalue	2.59	1.34
% of variance	51.7	26.7

Note: RC, reading comprehension; DEC, decoding; LC, listening comprehension; ORT, orthographic knowledge; MOR, morphological knowledge.

Table 3. Summary of means in % and SD and intercorrelations of all measures by grade.

	Grade 1[a]							Grade 2[b]	
	M	*SD*	1	2	3	4	5	*M*	*SD*
1. RC	66.2	18.4	—	0.59*	0.67*	0.71*	0.65*	64.2	22.1
2. DEC	65.1	32.4	0.64*	—	0.53*	0.74*	0.54*	65.2	29.9
3. LC	55.7	18.0	0.65*	0.47*	—	0.59*	0.66*	72.2	18.3
4. ORT	63.1	16.5	0.62*	0.58*	0.39*	—	0.62*	76.6	15.5
5. MOR	57.5	16.8	0.73*	0.71*	0.71*	0.59*	—	68.0	16.4
	Grade 3[c]							Grade 4[d]	
	M	SD	1	2	3	4	5	*M*	*SD*
1. RC	66.1	22.1	—	0.50*	0.64*	0.59*	0.71*	65.4	17.4
2. DEC	61.2	28.9	0.49*	—	0.34*	0.63*	0.67*	65.3	28.2
3. LC	61.0	22.5	0.66*	0.39*	—	0.54*	0.62*	72.9	20.2
4. ORT	74.9	13.9	0.70*	0.61*	0.58*	—	0.67*	81.3	10.6
5. MOR	61.2	16.1	0.74*	0.58*	0.67*	0.72*	—	70.0	15.7
	Grade 5[e]							Grade 6[f]	
	M	*SD*	1	2	3	4	5	*M*	*SD*
1. RC	60.2	20.6	—	0.49*	0.53*	0.69*	0.66*	69.0	20.5
2. DEC	67.6	27.3	0.47*	—	0.35*	0.61*	0.63*	70.6	26.4
3. LC	62.1	16.5	0.50*	0.23*	—	0.47*	0.56*	70.0	17.5
4. ORT	78.4	10.9	0.70*	0.61*	0.38*	—	0.70*	81.8	10.1
5. MOR	75.4	13.6	0.70*	0.60*	0.44*	0.72*	—	79.1	13.6

RC, reading comprehension; DEC, decoding; LC, listening comprehension; ORT, orthographic knowledge; MOR, morphological knowledge.
Note: Intercorrelations for first, third and fifth grades are presented below the diagonal, and intercorrelations for second, fourth and sixth grades are presented above the diagonal.
[a]$n = 115$.
[b]$n = 253$.
[c]$n = 252$.
[d]$n = 255$.
[e]$n = 256$.
[f]$n = 254$.
*$p < .01$.

morphology in Table 3). The correlations between all the variables were all statistically significant ($p < .01$). Specifically, the correlation between decoding and reading comprehension was the largest in the first and second grades and then decreased slightly and stabilised from the third grade onwards (Table 3). A relatively similar pattern was found for the correlations between listening and reading comprehension. The medium-to-large correlations found between decoding and listening comprehension in the first and second grades decreased gradually and became small in the fifth and sixth grades. The correlations between orthographic knowledge and both decoding and reading comprehension were large and stable across the grades. Similarly, large and consistent correlations were found between orthographic and morphological knowledge. Finally, the correlation between

Table 4. Summary of path analyses coefficients of variables for SVR and SVR-A by grade.

		SVR					SVR-A				
Grade	Variables	*B*	*SE*	β	*p*	R^2	*B*	*SE*	β	*p*	R^2
1[a]	DEC	0.240	0.041	.427	.000	0.56	0.072	.047	.127	.127	0.66
	LC	0.455	0.074	.446	.000		0.315	.071	.310	.000	
	ORT						0.270	.081	.243	.000	
	MOR						0.337	.099	.310	.000	
2[b]	DEC	0.247	0.038	.335	.000	0.53	0.043	.044	.059	.327	0.63
	LC	0.593	0.062	.490	.000		0.349	.066	.288	.000	
	ORT						0.559	.092	.388	.000	
	MOR						0.254	.076	.186	.000	
3[c]	DEC	0.213	0.037	.279	.000	0.50	0.011	.038	.015	.770	0.64
	LC	0.542	0.047	.552	.000		0.237	.051	.247	.000	
	ORT						0.475	.095	.300	.000	
	MOR						0.446	.082	.346	.000	
4[d]	DEC	0.224	0.032	.364	.000	0.41	0.016	.039	.026	.678	0.54
	LC	0.358	0.044	.418	.000		0.119	.049	.139	.015	
	ORT						0.275	.104	.168	.008	
	MOR						0.545	.080	.492	.000	
5[e]	DEC	0.282	0.039	.374	.000	0.38	0.007	.039	.010	.885	0.60
	LC	0.512	0.063	.411	.000		0.256	.055	.205	.000	
	ORT						0.728	.115	.385	.000	
	MOR						0.512	.094	.337	.000	
6[f]	DEC	0.275	0.040	.355	.000	0.40	0.024	.043	.031	.572	0.56
	LC	0.481	0.061	.412	.000		0.233	.059	.199	.000	
	ORT						0.849	.126	.417	.000	
	MOR						0.350	.099	.233	.000	

Note: DEC, decoding; LC, listening comprehension; ORT, orthographic knowledge; MOR, morphological knowledge; SVR, simple view of reading; SVR-A, simple view of reading for Arabic.
[a]$n = 115$
[b]$n = 253$
[c]$n = 252$
[d]$n = 255$
[e]$n = 256$
[f]$n = 254$.

morphological knowledge and reading comprehension was consistently slightly higher than with decoding and even than with listening comprehension.

To address our research questions, two path models were constructed for each grade. The first model addressed the first research question and examined to what extent the SVR explained reading comprehension in Arabic. Table 4 presents the results of this analysis for each grade. The basic version of the SVR model accounted for 56% of variance in the first grade, which diminished gradually until the fourth grade and then stabilised at approximately 40% (of explained variance) between the fourth and sixth grades. In all

the grades, the contribution of both decoding and listening comprehension to reading comprehension was significant ($p < .001$). The standardised coefficients showed that the contribution of decoding was highest in the first grade ($\beta = .43$), diminished gradually until the third grade ($\beta = .28$), and then remained stable between the fourth and the sixth grades ($\beta = .36$). In contrast, the contribution of listening comprehension increased between first grade ($\beta = .45$) and third grade ($\beta = .55$) and then decreased in the fourth grade ($\beta = .42$) and remained stable until the sixth grade.

To address the second research question, an extended version of the basic SVR model was constructed to investigate the additional contribution of orthographic and morphological knowledge to reading comprehension (Figure 1). The results of this extended model (referred to as SVR-A, for Arabic) are presented for each grade in Table 4. This analysis revealed first that the inclusion of the morphological and orthographic knowledge explained an additional 10% of the variance in the first and second grades, an additional 14% of the variance in the third and fourth grades and an additional 22–16% of the variance in the fifth and sixth grades. Generally speaking, it was observed that the extended Arabic model accounted for a maximum of 66% of the variance in the first grade, and this decreased to 56% in the sixth grade. Moreover, there was a strongly marked decline in the explained variance in the fourth grade relative to the third. The most interesting observation in this extended version of the SVR-A was the fact that the contribution of decoding to reading comprehension disappeared and was not significant even in the first grade. In addition, the contribution of listening comprehension to reading comprehension was much weaker than in the basic model, and it declined progressively until reaching a minimum in the fourth grade ($\beta = .14$; $p < .05$).

Regarding the contributions of orthographic and morphological knowledge, they were significant (almost always at $p < .001$) in all grades. The contribution of orthographic knowledge intensified as the children progressed through grades, but this trend was broken ($\beta = .17$, $p < .01$) in the fourth grade and reached its maximum in the sixth. The morphological contribution already found in the first grade ($\beta = .31$) decreased in the second grade ($\beta = .19$) and strengthened again to reach its peak in the fourth grade ($\beta = .49$); it then diminished again in favour of orthographic knowledge.

Discussion

The current study is the first large-scale cross-sectional investigation of reading comprehension in Arabic. We examined the validity of the SVR model in Arabic throughout the first six grades of school. In addition, we investigated how the orthographic and morphological characteristics of this language contributed to reading comprehension beyond decoding and listening comprehension. Our results revealed that while the basic SVR model explained 56% of the variance in the first grade, this decreased gradually to 40% in the sixth grade. The Arabic-extended model tested here, in which orthographic and morphological knowledge were included, explained an additional 10–22% of the variance in the different grades. Both models explained a moderate portion of variance, which tended to weaken as the children became more skilled in reading. The fact that a significant portion of the variance was not explained by the two models may suggest that the complex process of reading comprehension relies on factors other than those examined here (Aaron et al., 2008; Katzir et al., 2009).

The contribution of both decoding and listening comprehension to reading comprehension was consistently significant in the basic model of the SVR. This observation is consistent with findings from other studies of various languages and orthographies, including English, Greek and Hebrew (Johnston & Kirby, 2006; Katzir et al., 2009; Kendeou et al., 2012; Kirby & Savage, 2008; Vellutino et al., 2007). Whereas the contribution of decoding was similar to that of listening comprehension in the first grade, the contribution of listening comprehension became much stronger in the second and third grades and was somewhat stabilised in the fifth and sixth grades. This similarity between the two components in the first grade contrasts with the view that the contribution of listening comprehension to reading comprehension in transparent orthographies should be more dominant and influential than that of decoding (Catts et al., 2005; Duke et al., 2004). The contribution of decoding weakened as the children became more skilled, while the contribution of listening comprehension simultaneously intensified. In both cases, the trend of prediction changed in the fourth grade and stabilised later. These results support other findings, suggesting that the contribution of decoding and listening comprehension varies in the different stages of literacy development (Chen & Vellutino, 1997; Storch & Whitehurst, 2002). Thus, it seems that decoding has a critical role in the very early stage (first grade) of learning to read (Chen & Vellutino, 1997), and then its impact diminishes to give a more prominent place to listening comprehension in the following stages.

The correlation between decoding and listening comprehension suggests that, despite loading in two separate factors, these components are not dissociated, particularly in the first ($r = .47$) and second ($r = .52$) grades. This finding, which contrasts with previous findings for English (Cain et al., 2004), indicates that decoding and listening comprehension rely on some common subskills (linguistic or cognitive or both). The difference with English observed here might be explained in terms of differences in orthographic transparency between Arabic and English, hence the necessity to take into account the specificities of each language when assessing reading comprehension and literacy processes in general (Florit & Cain, 2011; Share, 2008). In transparent orthographies, the contribution of decoding in more skilled readers is reported to decrease, whereas the contribution of linguistic comprehension is reported to increase (Florit & Cain, 2011). Here, the consistent contribution of decoding until the sixth grade needs to be interpreted with caution in view of the fact that the vowelised Arabic orthography (used in this study) is considered transparent. A possible explanation for the differences between our results and others from transparent orthographies might be due to the diglossic situation of Arabic-speaking children who, in this age range, had been only briefly exposed to the auditory literary language. This explanation appears highly plausible when one considers the fact that the contribution of listening comprehension was expected to dominate in the first grade.

In the SVR-A, in addition to the added variance beyond that explained by the basic SVR, dramatic changes in the contribution of the basic components were observed. In particular, we found that the contribution of decoding was no longer significant, even in the first grade. A similar finding was presented by Landi (2010), who examined reading comprehension in adult German readers. The author reported that while decoding explained 8% of the variance when entered first into the regression, its contribution nearly disappeared (3%) when decoding was entered after vocabulary and other high-level skills (Landi, 2010). Other similar findings were obtained from Greek-speaking second, third and fourth-grade children (Protopapas et al., 2007). These results again support the view that emphasises the differential influence of specific orthographic systems on reading comprehension (Florit & Cain, 2011). Our results are consistent with several studies that

documented the contribution of orthographic knowledge to reading comprehension, including English (MacArthur et al., 2010; Mehta et al., 2009; Silverman et al., 2013), Arabic (Elbeheri et al., 2011) and Hebrew (Joshi et al., 2015; Primor et al., 2011). The observation here that the orthographic contribution was significant in all grade levels is similar to recent findings from Hebrew in second to tenth-grade children (Joshi et al., 2015).

The orthographic contribution might derive from the correlation between this component and fluency, which is critical for reading comprehension (Fuchs et al., 2009; Perfetti, 2007; Tilstra et al., 2009). Researchers have suggested that, in Arabic, the orthographic complexity of the language slows its processing (Ibrahim et al., 2002). Slow processing is hypothesised to reduce fluency and overload working memory at the expense of higher-order skills such as reading comprehension (Gathercole et al., 2006; Pikulski & Chard, 2005). Indeed, the formation of orthographic patterns allows the reader to abandon relying on basic decoding processes, enabling them to deal with bigger units such as the orthographic patterns that, in turn, enhance fluency and permit the allocation of attentional resources to higher-order processes. Hence, the absence of the contribution of decoding to the SVR-A might be explained by the hypothesis of lexical quality (Perfetti & Hart, 2001). This view assumes that good phonological, orthographic and semantic representations can enable the freeing of cognitive resources for the higher-order comprehension process. In the presence of orthographic contribution, the effects of decoding on reading comprehension might have been mediated by lexical quality. Indeed, previous research showed that the semantic component (as reflected in oral vocabulary) was the strongest predictor of reading comprehension, even after controlling for word reading and phonological awareness (Muter et al., 2004), especially in the higher grades (Ouellette, 2006; Ouellette & Beers, 2009).

The contribution of listening comprehension to the SVR-A remained significant even after adding the orthographic and morphological knowledge to the model. Here again, this might be explained by the lexical quality hypothesis (Perfetti & Hart, 2001) because listening comprehension contains both phonological and semantic components. However, the trend observed for the contribution of listening comprehension in the SVR (increasing from the first to the third grade) was inverted in the SVR-A. The increasing contribution of listening comprehension with increases in grade is consistent with findings from English (Catts et al., 2005; Chen & Vellutino, 1997). The inversion of this trend in the SVR-A might reflect the particular effects of orthographic knowledge in general and of the specificities of the Arabic orthographic system on reading comprehension in particular.

Similar to the contribution of orthographic knowledge, morphological knowledge was consistent across grades, a finding that supports the critical role of morphology in reading comprehension, particularly in Semitic languages (Abu-Rabia, 2007; Carlisle, 2000; Deacon & Kirby, 2004; Primor et al., 2011; Nagy et al., 2006; Ravid & Mashraki, 2007; Ravid & Schiff, 2006; Schiff et al., 2011; Siegel, 2008). This contribution was already present in the first grade, peaked in the fourth grade ($\beta = .49$), and then decreased smoothly towards the sixth grade. The consistent contribution of morphological knowledge might be explained by the role that morphology in Semitic languages seems to play in extracting phonological information from print, even in vowelised words (Bar-On & Ravid, 2011; Saiegh-Haddad, 2013; Saiegh-Haddad & Geva, 2008). Although not tested in the study, the contribution of morphology might also be explained by its strong link with vocabulary, where it is thought to be critical for the development of the mental lexicon (Boudelaa & Marslen-Wilson, 2011; Carlisle, 2000).

Our results showed that the basic SVR, constructed initially for English and explaining between 70 and 90% of the variance in reading comprehension, could explain ~50% in Arabic. These results support the validity of the SVR model for Arabic but emphasise the need to address the uniqueness of the language at hand (Share, 2008) because the inclusion of orthographic and morphological knowledge explained 10–20% more of the variance. The need to address language specificities appears to be particularly crucial when speaking about 'major' differences between languages, such as that of the depth/transparency of the orthographic systems. In fact, the contribution of decoding to reading comprehension was expected to disappear around the second and third grades as in other transparent orthographies (Florit & Cain, 2011), as this is a time when children progress to more efficient and fluent reading. The consistent involvement of decoding up to the sixth grade (in the basic model of SVR) can thus be considered a strong indication that Arabic orthography behaves not as a transparent but rather as a deep orthography. Additionally, this long-lasting involvement of decoding provides further evidence regarding the difficulty of reading in Arabic (Abu Ahmad et al., 2014) and suggests that children continue to some extent to rely on the primary grapho-phonemic conversion processes (i.e. decoding) until later and thus are not very efficient in their reading. Thus, it appears that the complexity of the Arabic orthographic system (Ibrahim et al., 2002) obliges the reader to rely on decoding processes that require more cognitive resources, which are necessary for reading comprehension (Perfetti, 2007).

Theoretical and instructional implications

The results of the present study highlight some important theoretical and pedagogical implications. Firstly, for the special case of Arabic, this study emphasises the fact that Arabic orthography (even when vowelised) behaves, to some extent, as a deep one. Additionally, it points to the need to take into account the rich morphology and complex orthography of Arabic when considering models of reading comprehension. From the pedagogical perspective, the identification of specific predictors and the understanding of their relation to reading comprehension in the various phases of reading acquisition should contribute to improved screening, assessment and intervention strategies. To improve decoding, interventions should focus on phonological awareness, letter knowledge and phonemic decoding (Carroll et al., 2011; Brooks & Torgerson, 2008). With respect to listening comprehension, which involves a wide range of higher oral language skills, intervention should focus mainly on vocabulary and syntax (Snowling & Hulme, 2012), as well as on morphology (Taha & Saiegh-Haddad, 2016). Particular emphasis should be placed on orthographic knowledge, and to accomplish this, different strategies should be devised for learning, storing and recognising orthographic patterns by using, for example, repeated reading and choral and echo reading (Neddenriep et al., 2010).

Limitations and future research

This study showed that approximately 40% of the variance in reading comprehension was not explained by the SVR-A. This finding might be due to the absence of other important cognitive and linguistic factors in the model tested here. Additionally, for a more comprehensive model of reading comprehension to be proposed, future research should indeed take into account environmental, emotional, motivational, family literacy and self-concept

factors. One of the limitations of this study might have been the fact that only vowelised texts were used. The continuous reliance on decoding observed in the SVR might be because the children were asked to consider the phonological information provided by vowelisation. Determining whether using unvowelised texts would change the prediction of reading comprehension necessitates studies that compare vowelised and unvowelised texts. Another limitation of this study is the fact that only one measure of reading comprehension was used. Given that different measures of reading comprehension might elicit different predictions (see Cutting & Scarborough, 2006; Kendeou et al., 2012), the selection of the specific type of text used here might have affected our findings. Finally, the fact that several of the measures have fairly low reliability might arguably have influenced the proportion of variance explained here. Hence, future research should combine different types of text and verify their reliability and validity for assessing reading comprehension in this language.

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Appendix 1

Examples of the linguistic tasks used to predict reading comprehension in the different grades. The first cells are always presented with the English translation of the words or their phonological transliteration.

Grades			
	Decoding		
1	مَزيجُ (*mazj:χu*)	سافَ (*sa:fa*)	راذي (*ra:ðj:*)
2	تَفْجيم	قَواشِر	نَعيل
3-4	ضَريكَةٌ	فَرَعوا	أوماحُ
5-6	الشَرائِحُ	أوْجالِك	اِمْتَحَوا
	Parsing		
1-6	دارمنأكلباب (*house-who-ate-door/da:rman?kalba:b /da:r/man/?kal/ba:b/*)	عادكرسيمعراعي (*returned-chair-with-shepherd/ʕadkursimaʕra:ʕi/ /ʕa:d/kursi/maʕ/ra: ʕi/*)	فادياًنلعبتفاحة (*Fadi-that-played-apple/fa:di?anlaʕbtuffaħa/= /fa:di?an/laʕb/tuffaħa/*)
	Orthographic choice		
1-2	فادي (*Fa:di/= /Fa:di/masculine noun*)	ضور (*dˤw:r/=, pseudoword*)	باب (*ba:b/= door/*)
3-4	عصا	سغير	خاتم
5-6	لُئم	إسطبل	قَمحَتن
	Inflecting verbs and nouns		
1-2	ك.ت.ب (هي) في الماضي: (كَتَبَتْ) (*k.t.b, she, past /=katabat/she wrote*)	ك.ت.ب (هو) في المضارع: (يَكْتُبُ) (*k.t.b, he, present /=jaktub/he writes*)	ك.ت.ب (انت) في الأمر: (اُكْتُب) (*k.t.b, you, imperative /=ʔuktub/write*)
3-4	خ. ر. ج:(أنتَ) في المضارع: (تَخْرُجُ)	خ. ر. ج: أنتَ في الأمر: (اُخْرُجْ)	خ. ر. ج: أنتَ في الماضي (خرجْتَ)
5-6	ثُقاحة: (انتم) ثُقاحتُكم	ثُقاحة: (هي) ثُقاحتُها	ثُقاحة: (هو) ثُقاحتُهُ
	Derivation of words in context		
1-2	ط .ع. م: أم علي في المطبخ تُحضّر آلْ (طَعام) ***t.a.m****: Om Ali (is) in the kitchen preparing /al=**tˤaʕa:m**/the food*)	د. ه .ن نَدْهَنُ الحائطَ بال(دهان) ***d.h.n****: we paint the wall with /al =**dha:n**/the paint*)	ك.ت.ب: قُرأ سالِمٌ دُروسَهُ من ال (كتاب) ***k.t.b****: Salem read his lessons from the /al=**kita:b**/the book*)
3-4	ح. س. ب: نَتَعلّمُ الأعْدادَ في دَرْس آل (حِساب)	م. ر. ض: بالْمُسْتَشفى تُعْمَلُ آل (مُمَرِّضَة)	س. ر. ق: قَبَضَتِ ألشُرْطَةُ عَلى آل (سارِق)
5-6	ر. ك. ب: بِألْبَحْرِ نَرْكَبُ ال: (مَرْكَب)	ح. م. ل:ساعَدْتُ السَّيِّدَةَ ال: (حامِل)	ط. ع. م: يُقَدِّمُ النّادِلُ آلطّعامَ بِآل: (مَطْعَم)
	Root awareness		
1-2	مَسْموع ضَجَّة سامِع (*heard, noise, hearing / root **s.m.** ʕ, =masmuwʕ, dˤaʒʒa, **sa:me**ʕ*)	رَسّام يَرْسُم لَوْحَة (*painter, he paints, drawing / root **r.s.m.**= rassa:**m**, jar**s**um, lauwha/*)	حَصَدَ يَحْصُد زَرَعَ (*he: reaped, reaps, plants /root **h.sˤ.d.** = **has**ˤ**ad**a, ja**ħs**ˤ**ud**, zara**ʕ**a*)
3-4	سَريعًا مُسْرِع عَروسًا اسْراع	رَقْصة يَرْقُص راقِص قَصير	نِمام سرير نام نَوْم
5-6	لِباس مَلابِس إلبِس سالِب	مُدَرِّس دَرَسَ سَرَدَ مَدْرَسَة	تَحَرُّر حَرَّرْنا حُرِّيَة احترام
	Patterns awareness		
1-2	رَسْمٌ – صَوْتٌ (*drawing- voice /=**rasm**un-s**ˤ**a**uwt**ˤ**un/*)	جَميلٌ – شَكْلٌ (*beautiful-shape /=**ʒam**i:**l**un-**ʃak**lun/*)	حَزِنَ – فَرِحَ (*felt sad-felt happy /=**ħazen**a-**far**e**ħ**a/*)
3-4	مَفْقودٌ – مَكْسورٌ	قالَ – سألَ	شَرِبَ - عَطْشانٌ
5-6	يُغَرِّدُ – يَتَحَوَّلُ	أطْعَمَ – اقْتَرَبَ	تَسَلَّمَ – تَعَلَّمَ

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