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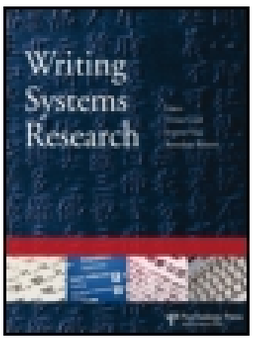

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Deep and shallow in Arabic orthography: New evidence from reading performance of elementary school native Arab readers

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ABSTRACT

The current study tested the impact of vowelisation on reading speed and accuracy of Arabic words among skilled and poor native Arabic readers using a cross-sectional procedure. One hundred and forty-three skilled and 146 poor native Arab readers from northern Israel (second, fourth and sixth grades) read two lists of full vowelised and non-vowelised words. The results indicate that among the readers, the non-vowelised words were read more accurately than the vowelised words. For the skilled poor readers, such significant differences were found within the older reader groups only (the fourth and sixth grades). Differences in the speed of reading vowelised and non-vowelised words were found within the older groups only in both groups of readers. The results are discussed in light of different approaches in the field of visual word recognition. It is suggested that vowelisation for skilled and older readers could cause a visual load during the process of the visual recognition of words and may be considered as 'redundant information'.

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The past two decades have witnessed a large scientific interest on the impact of the unique orthographic features of different orthographic systems on the process of reading and visual word recognition (for example, see Frost, 2005; Seymor, Aro, & Erskine, 2003; Simon, Bernard, Lalonde, & Rebaï, 2006; Taha et al., 2013; Ziegler et al., 2010).

Orthographies differ in their consistency between the orthography and the phonology, what is known as orthographic depth (Frost, 2005; Frost, Katz, & Bentin, 1987). The variation of the orthographic depth level in different orthographies was found to affect the rate of reading acquisition among readers across different languages. For example, according to the study of Seymor, Aro, and Erskine (2003), it was found that beginning readers from more transparent European languages reached fluent reading earlier than beginning readers from less transparent orthographies. Actually, it is well evident that reading in transparent orthographies relies on direct mappings between the graphemes and the phonemes (Ziegler & Goswami, 2005), accordingly, such transparency was considered as a facilitator for reaching reading fluency at early stages of reading acquisition (Bruck, Genesee, & Caravolas, 1997; Frith, Wimmer, & Landerl, 1998; Goswami, Gombert, & de Barrera, 1998; Goswami, Ziegler, Dalton, & Schneider, 2001). On the other hand, reading in non-transparent orthographies, where opaque grapheme-phoneme mappings exist, forces the beginner reader to rely considerably on further cognitive resources during

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the process of word recognition (Frost, 2005). Generally, these further cognitive demands during reading could be the main reason for the delay in reaching reading fluency in non-transparent orthographies (Coltheart, 2005; Geva & Siegel, 2000; Katz & Frost, 1992).

This assumption behind the contribution of orthographic transparency to reading fluency, and how such level of transparency affects the modulation of underlying cognitive processes in reading, was tested recently by Ziegler et al. (2010). Ziegler and his colleagues tested the role of phonological awareness, memory, vocabulary, rapid naming and nonverbal intelligence in reading performance across five different languages, which differed in their orthographic transparency. The results indicate that phonological awareness was the main factor that contributes to reading performance in the different orthographies. However, this impact was modulated by the transparency level of the orthography. Ziegler and Goswami (2005) proposed the 'grain size theory' which postulated that beginning readers in non-transparent orthographies encounter different challenges that could also affect their phonemic awareness development as a result. One main challenge, as it was described by Ziegler and Goswami, is the granularity of spelling-to-sound mappings. This granularity challenge reflects the fact that there are many more orthographic units to learn when accessing the phonological system. Accordingly, reading proficiency in non-transparent orthographies depends on the resolution of this challenge, what comes to delayed fluency in reading.

Other researchers do not agree with the notion that the transparency of a writing system systematically influences the cognitive skills associated with reading development. For example, Vaessen et al. (2010) investigated the cognitive dynamics of reading fluency of different word types in Grades 1–4 in three orthographies differing in their levels of transparency (Hungarian, Dutch and Portuguese). The overall results showed that the contribution of phonological awareness remained significant in all grades, but decreased as a function of grade, whereas the contribution of rapid naming increased. The authors postulated that cognitive development of reading skill is fairly universal in alphabetic scripts and that differences in orthographic depth will not recruit different cognitive processes, but will mainly be expressed in rate of reading development only. It is important to mention here that this postulation could be problematic in light of the fact that Roman scripts share a lot of similar orthographic features while non-Roman scripts have their own unique features that could differently affect the cognitive process involved in the reading process. This latter view has been described by David Share in the form of the Anglocentrism hypothesis (Share, 2008; see also Share & Daniels, 2015).

Unlike Roman scripts where each written language could be characterised as shallow or deep, depending on how its orthography reflects the phonology, other orthographies have more than one orthographic representation of written words, a shallow and deep representation as well (Katz & Frost, 1992). Arabic and Hebrew are two languages with such an orthographic system. For both orthographies, written words are composed from letters that represent the consonant and long vowels in addition to diacritics that could appear above and below the letters within the whole pattern of the written words. Those diacritics represent the short vowels and enable the reader to infer the specific pronunciation of the written word, especially when the reader encounters new and non-contextual words. Hence, the role of those diacritics is vowelisation of the written words. Accordingly, vowelised written words in Hebrew and Arabic fit the condition of high transparent orthography. The written texts and materials for beginning readers are usually presented with the full vowelised form of the words, while by the end of elementary school, non-vowelised words are being used in the different reading materials.

One main result of the unvowelisation of the written words is the high amount of homographs. Within this case, the reader needs to rely heavily on the general context of the sentence or even the whole text for being able to infer the specific pronunciation and meaning of the written word. For example, the following words in Arabic [<رِجْل> <Foot>], and [<رَجُل> <Man>] could have the same letters when omitting the vowelisation diacritics, i.e., <رجل>. Accordingly, identifying the specific pronunciation and meaning of the words during reading will be possible by relying on contextual clues.

Previous studies tried to examine the effect of the vowelisation of the written words, in Hebrew and Arabic, on the process of reading accuracy, rate and comprehension. For example, Shimron and Sivan (1994) tested skilled bilingual Hebrew native speakers in reading two passages in Hebrew (one vowelled and the other unvowelled) and two in English. The reading time was shorter in English than in unvowelled Hebrew, but not shorter than in vowelled Hebrew. Comprehension of English was not significantly different from comprehension of vowelled Hebrew, but was significantly better than comprehension of unvowelled Hebrew. It was suggested that vowelisation contributes to the process of word recognition in Hebrew because of the phonological contribution of the vowel diacritics in the process of reading. Similarly to Hebrew, different researchers tested the functional contribution of vowels to the process of reading in Arabic (Abu Rabia, 1996, 1997a, 1997b, 1998, 1999, 2007, 2012; Ibrahim, 2013). In one of the pioneering studies in Arabic orthography, Abu Rabia (1996) investigated the role of context and vowels in word recognition in Arabic among skilled readers. The results indicated that vowelisation and context were the main facilitators in word recognition among the skilled readers. This finding was replicated within different studies by Abu Rabia (1997a, 1997b, 1998, 2012). Even more, Abu Rabia (2001) found that reading comprehension of bilingual native Arab readers who speak Hebrew as a second language was better for vowelised than for non-vowelised texts in Arabic or Hebrew. Consistently, Abu Rabia (2007) found that vowelisation contributes significantly to reading Arabic words among both skilled and dyslexic native Arab readers from different ages. By contrast, recent findings of Ibrahim (2013) indicate that unvowelised words were read more accurately and more quickly than the full vowelised words among native Arab adolescent readers. These recent findings were explained by Ibrahim (2013) as a result of visual load that the vowelisation diacritics produce when reading familiar words.

Given the inconsistent findings among different studies that tested the contribution of vowelisation on reading in Arabic, and given the lack of clarity of the developmental aspect of this contribution among typical and poor readers, the aim of the current study is to investigate the developmental contribution of vowelisation on reading Arabic words among typical (or skilled) and poor readers. In light of previous research in this field (Abu Rabia, 1997a, 1997b, 1998, 2012; Ibrahim, 2013), it can be assumed that vowelisation may enhance word recognition for beginner readers due to their reliance on non-lexical reading strategies, while for older readers who rely mainly on lexical strategies, vowelisation may behave as a distractor and slow their word recognition.

Method

Participants

The study tested a total of 289 typical and poor readers in three age groups: second grade (Typical readers, $N = 48$, Poor readers, $N = 48$), fourth grade (Typical readers, $N = 48$, Poor readers, $N = 50$) and sixth grade (Typical readers, $N = 47$, Poor readers, $N = 48$). Participants were sampled from 22 different Arab schools in northern Israel. Entering the schools was allowed after getting the approval and consent of the parents and Ministry of Education in Israel. Data collection was conducted by 22 students of special education who were trained carefully in how to use the tasks and to implement all the stages of the study. All participants were speakers of the northern Palestinian vernacular of Arabic. See Table 1 for age means and gender distribution within the different groups.

Screening for the poor readers was based on low achievement models (Fletcher & Denton, 2003; Jiměnez, Siegel, & Lòpez, 2003; Lyon, Fletcher, & Barnes, 2002). The first step in the screening procedure was administering a spelling test to each age group with the aim of identifying students with spelling difficulties. Spelling difficulties are a significant predictor of reading difficulties in the absence of other difficulties like emotional, socio-economical and sensory ones (Jiměnez, Siegel, &

Table 1. Age means (in years) and gender distributions within the different groups.

Reader	*Grade*	*Gender*	*N*	*Age (M)*	*SD*
Typical Readers	Second grade	Male	19	7.94	0.32
		Female	29	8.22	0.25
		Total	48	8.11	0.31
	Fourth grade	Male	18	9.99	0.20
		Female	30	9.99	0.33
		Total	48	9.99	0.29
	Sixth grade	Male	18	12.01	0.31
		Female	29	11.99	0.24
		Total	47	12.00	0.27
	Total	Male	55	9.94	1.71
		Female	88	10.07	1.56
		Total	143	10.02	1.62
Poor Readers	Second grade	Male	24	7.90	0.25
		Female	24	8.05	0.28
		Total	48	7.98	0.27
	Fourth grade	Male	30	10.06	0.29
		Female	20	9.91	0.35
		Total	50	10.00	0.32
	Sixth grade	Male	31	12.00	0.29
		Female	17	11.97	0.36
		Total	48	11.99	0.31
	Total	Male	85	10.16	1.67
		Female	61	9.75	1.63
		Total	146	9.99	1.66

Lòpez, 2003; Fletcher, & Denton, 2003; Lyon et al., 2002). A spelling test for each grade was adopted from Abu Rabia and Taha (2006) and was used with each grade level, namely, spelling test for the second grade (α = .88)[1], fourth grade (α = .94), and sixth grade (α = .82). Students falling below the 25th percentile on the spelling test were selected as being at risk for reading difficulties. Students with scores above the 90th percentile on the spelling test were selected as candidates for skilled or typical reading abilities.

The next step in the selection procedure was testing the reading abilities within each of the two former groups. Two reading tasks were used: (1) reading a list of words that were selected from the students' readers to ensure familiarity and suitability to the children's reading and language level. Three lists were developed for each grade: one for the second grade, the fourth grade and the sixth grade. Each list consisted of 30 words. (2) Reading a text aloud. Three texts were selected, one for each level of grade. A number of candidate texts were presented to three elementary school teachers of Arabic who were asked to judge the suitability of the texts to each grade level. The texts used were those for which at least two out of the three judges had judged as suitable for a given grade level.

A cut-off of below 70% accuracy in reading both tasks (i.e., reading the list of words and the text) was used to screen the student as having a difficulty in reading. Also, a cut-off point of above 90% accuracy in both reading tasks was determined to identify the student as a skilled reader. Readers who scored below 70% accuracy on one test and above 70% on the other were excluded. In addition to test data, pedagogical, familial, and developmental information was gathered about each participant to ensure that their reading difficulty was not a result of sensory disability or emotional disturbances. Students with these disturbances were excluded from the study.

[1]The values of Cronbach's alpha are as reported in Abu Rabia and Taha (2006).

Materials

Reading tasks

A: Vowelised isolated real words—the task consisted of 30 words (α = .87). The words used in this task targeted six different aspects of Arabic phonology and morphology. Each category consisted of six words. A total of 30 words were presented within this task as in the following categories: (1) words with diglossic phonemes: words containing Standard Arabic phonemes that are not within the spoken vernacular of the participants. For example, (قارِب) (2) words with emphatic phonemes: words containing velarised phonemes which differ from non-velarised phonemes in one secondary phonetic feature (velarisation) but share with it all three main phonetic features (voicing, place of articulation and manner of articulation), both velarised and non-velarised phoneme pairs exist in Arabic and they are represented in the Arabic orthography using different letters. For example, (ضَبابٌ) (3) words with a diglossic syllabic structure. Words that have a standard syllabic structure which is not frequent in the spoken vernacular of the participants. For example, (كَبْشٌ) (e.g., CVCC); (4) morphologically transparent regular words: words that have a transparent morphological structure (no homophonic letters) and a regular mapping between their sounds and reading. For example, (اِستَجْمَعَ) Morphological transparent irregular words: words that have a transparent morphological structure but which are irregular. Reading these words requires the use of morphological cues. For example, .اِنتَقَلَ. The letter length of the vowelised words ranged from three to six letters (M = 4.13 ± 0.89), while the syllabic length ranged from one to four (M = 2.5 ± 1.13).

B: Non-vowelised isolated real words—this task was composed of 30 words (α = .88). The current task was composed with keeping full matching with vowelised reading task, considering the different linguistic and length features as following: the words used in this task targeted five different aspects of Arabic phonology and morphology. Each category consisted of six words. A total of 30 words were presented within this task as in the following categories: (1) words with diglossic phonemes: words containing Standard Arabic phonemes that are not within the spoken vernacular of the participants. For example, (قليل) (2) words with emphatic phonemes: words containing velarised phonemes which differ from non-velarised phonemes in one secondary phonetic feature (velarisation) but share with it all three main phonetic features (voicing, place of articulation and manner of articulation), both velarised and non-velarised phoneme pairs exist in Arabic and they are represented in the Arabic orthography using different letters. For example, (مطرب) with a diglossic syllabic structure. (3) Words that have a Standard syllabic structure that is not frequent in the spoken vernacular of the participants. For example (نبع) (e.g., CVCC); (4) morphologically transparent regular words: words that have a transparent morphological structure (no homophonic letters) and a regular mapping between their sounds and reading. For example, (تتابع) (5) morphologically transparent irregular words: words that have a transparent morphological structure but which are irregular. Reading these words requires the use of morphological cues. For example, (استفرض). The letter length of the non-vowelised words ranged from three to six letters (M = 4.16 ± 0.98), while the syllabic length rand from one to four (M = 2.3 ± 1.05).

Any significant differences in letter and syllabic length were found between the vowelised and non-vowelised words.

Procedure

Each participant was tested individually by one of the research assistants in a quiet room in the school which was isolated for the purposes of the study. The order of the tasks (vowelised and non-vowelised) was changed from one participant to another to avoid an order effect. Each list of words was presented on a different page. For each list the participant was asked to read the presented words as fast and as accurately as possible. A pre-training section of reading five words was implemented before starting the test in each case. Reading errors were recorded immediately by the research assistant. For the non-vowelised words, and because of the

homographs situation in this case of words, a reading error was considered as such when the pronunciation of the student did not meet any of the pronunciations that are compatible for the presented orthographic pattern of the non-vowelised word. Besides accuracy, the total reading time of each task was also measured using a stopwatch.

Results

Separate analyses were performed for accuracy and speed of reading.

Typical readers

Accuracy

A 2 x 3 ANOVA was performed on accuracy using word condition (vowelised vs. non-vowelised) and grade (second vs. fourth vs. sixth). The results revealed a significant effect of word condition [$F(1, 140) = 37.22$, $p < .001$], and a significant effect of grade [$F(2, 140) = 28.09$, $p < .001$], while the interaction of word condition by grade was not significant [$F(2, 140) = 2.39$, $p = .09$]. Non-vowelised words were read more accurately than vowelised words through all the grades among the typical readers group (see Table 2).

Reading speed

A 2 x 3 ANOVA was performed on the speed of reading the words as a function of word condition (vowelised vs. non vowelised) and grade (second vs. fourth vs. sixth). The results revealed a significant effect of word condition [$F(1, 140) = 31.81$, $p < .001$], and a significant effect of grade [$F(2, 140) = 62.32$, $p < .001$]. Also, a significant interaction of word condition by grade was found [$F(2, 140) = 4.52$, $p < .05$]. The significant interaction showed a non-significant difference between the speed of reading vowelised and non-vowelised words among the second-grade readers [$t(47) = 0.79$, $p = .33$], while within the fourth and the sixth grade, significant differences were found [$t(47) = 8.44$, $p < .001$] and [$t(46) = 5.3$, $p < .001$] for the fourth and the sixth grades respectively. The longest reading times were measured for reading the vowelised words (see Table 2).

Poor readers

Reading accuracy

The 2 x 3 ANOVA was performed on accuracy using word condition (vowelised vs. non-vowelised) and grade (second vs. fourth vs. sixth). The results revealed a significant effect of word condition [$F(1, 143) = 58$, $p < .001$], and a significant effect of grade [$F(2, 143) = 46.53$, $p < .001$] as well as a significant interaction of word condition by grade [$F(2, 143) = 4.21$, $p < .05$]. This significant interaction is due to the fact that no significant differences in word accuracy were found in reading vowelised compared to non-vowelised words among the second-grade readers [$t(47) = -1.8$, p

Table 2. Means and standard deviations for accuracy and reading time (speed) on reading vowelised and non-vowelised words among typical readers.

Grade		*% Accuracy reading vowelised words*	*% Accuracy reading non vowelised words*	*Time for reading vowelised words (seconds)*	*Time to read non vowelised words (seconds)*
Second	Mean	90.42	92.08	86.66	84.00
	SD	7.65	6.36	47.98	46.92
Fourth	Mean	93.33	97.43	40.73	30.54
	SD	5.41	3.09	12.43	9.10
Sixth	Mean	96.45	99.08	28.66	23.72
	SD	3.70	1.80	8.46	5.54

Table 3. Means and standard deviations for accuracy and reading time (speed) on reading vowelised and non-vowelised words among poor readers.

Grade		*% Accuracy reading vowelised words*	*% Accuracy reading non vowelised words*	*Time for reading vowelised words (seconds)*	*Time for reading non vowelised words (seconds)*
Second	Mean	56.18	59.17	209.94	200.21
	SD	16.16	16.60	112.85	100.03
Fourth	Mean	70.20	77.40	85.94	70.19
	SD	13.49	11.81	66.08	42.70
Sixth	Mean	76.18	84.86	54.94	47.31
	SD	9.87	7.01	22.72	17.65

= .078]. Conversely, significant differences were found among the older readers [$t(49) = -4.98$, $p < .001$] and [$t(47) = -7.6$, $p < .001$] for the fourth and the sixth grades respectively, where the highest reading accuracies were measured for reading the vowelised words (see Table 3).

Reading speed

A 2 x 3 ANOVA was performed on reading times as a function of word condition (vowelised vs. non vowelised) and grade (second vs. fourth vs. sixth). The results revealed a significant effect of word condition [$F(1, 143) = 13.15$, $p < .001$] and a significant effect of grade [$F(2, 143) = 70.83$, $p < .001$]. Conversely, a non-significant effect of word condition by grade was found [$F(2, 143) = 0.65$, $p = .52$]. Based on a priori considerations, a breakdown of the interaction was performed. This showed that vowelised and non-vowelised words were read equally fast among the second-grade readers [$t(47) = 1.23$, $p = .22$], while within the fourth and the sixth grades significant differences were found [$t(49) = 3.69$, $p < .01$ and $t(47) = 3.96$, $p < .001$] for the fourth and the sixth grades respectively. The longest reading times were measured for reading the vowelised words (see Table 3).

Discussion

The current study tried to investigate the role of the vowelisation on reading written Arabic words from a developmental point of view using a cross-sectional design. Previous studies revealed mixed results considering this role of vowelisation in reading Arabic words. The major body of research, which was implemented by Abu Rabia, highlighted the positive role of vowelisation on word recognition in Arabic and even on reading comprehension. Recent data from Ibrahim's study (2013), presents an opposite finding that non-vowelised words were read more accurately than vowelised words. The results of the current study revealed a developmental role of the effect of vowelisation on the accuracy and the speed of reading real words in Arabic among the reading groups, typical and poor readers. Within the typical readers group, non-vowelised words were read more accurately than vowelised words through all the age groups. However, considering the speed of reading, this effect of vowelisation was observed among the fourth and sixth graders but not among the second-grade readers. This finding might be a result of the fact that younger readers are less automated in word recognition and mainly perform reading tasks using non-lexical processes, where phenome-grapheme mappings form the basis of the reading process (Coltheart, 2005; Ehri & Snowling, 2005). Accordingly, this may slow reading words at all. Older readers may benefit from their sophisticated lexical knowledge and recognise the words in a more accurate and quick manner than younger readers. In this case, vowelisation could cause a visual load and distraction that may interrupt the fluent recognition of familiar words (Ibrahim, 2013). The results from the poor group of readers make this assumption a matter of debate. It can be postulated that poor readers do not have a sophisticated lexical knowledge but still exhibit advantage in reading non vowelised words compared to the vowelised words, specifically the older readers (the fourth and the sixth grades). In light of the fact that among the younger group of the poor readers, the reading of vowelised and

non-vowelised words had similar levels of accuracy and speed, it can be postulated that due to the immaturity of the lexical processes there is no advantage of reading non-vowelised words over the vowelised.

Considering the orthographic depth hypothesis (Frost, 2005), vowelised words fit the shallow orthographic situation, while non-vowelised words are compatible with the deep one. Accordingly, familiar vowelised words could be expected to be read faster and more accurately than non-vowelised words, because of the assumption that lexical and non-lexical activations are assumed to serve this process, while in reading non-vowelised words just lexical activations are at play. The findings resulted in the opposite to this assumption. Hence, in reading familiar words, the dominant activation is regarded as lexical process with suppression of the non-lexical processes. Therefore, the more visual information to be processed (as it occupies a larger visual space) the more cognitive resources are needed. This is costly, resulting in longer response times, even when the stimulus is familiar. It is important to mention here that the words within both reading tasks (vowelised and non-vowelised) were carefully matched in different orthographic aspects like length and syllabic structure, and were familiar words. Hence, the slowness in reading the vowelised words may be interpreted as a direct result of the existence of the vowelisation marks around the orthographic pattern of the word. This situation produces an orthographic density which slows the visual processing of the written words (Ibrahim, 2013). Accordingly, and as a direct result of this orthographic density, it could be assumed that the gaze duration rate of visual fixations on vowelised words might be longer than the gaze duration rate for non-vowelised words. These assumptions need further study using appropriate tools for tracking the eye movements and gaze duration rate and fixations during visual word recognition.

Considering this orthographic density, it can be assumed also that the differences in reading rate and accuracy of vowelised words versus non-vowelised words resulted from possible differences in the spatial frequency of the stimuli as could be found for other orthographic systems like Kanji and Kana characters (Horie et al., 2012) and for vowelised and non-vowelised Hebrew words (Bar-Kochva, 2011). Actually, the Japanese Kanji ideograms which are characterised by high spatial frequency (HSF) information elicited a longer latency of related brain visual processing activity than the Kana which are characterised by low spatial frequency (LSF; Horie et al., 2012). Similarly, vowelised Hebrew words (HSF) induced a longer latency of earlier visual processing-related brain potentials than the non-vowelised words (LSF; Bar-Kochva, 2011). In their study, Taha, Ibrahim and Khateb (2013) found that processing of full connected Arabic words was faster than the processing of non-connected words (words without spaces between the letters). The authors assumed that non-connected Arabic words are of a higher SF than words with full connected letters and thus at least some of the differences in the speed of processing the words might be explained by such physical differences. Accordingly, vowelised words are assumed to be of higher SF than non-vowelised words, thus, the difference in the speed of processing and accuracy might be attributed to their spatial frequency differences. Actually, this assumption of orthographic density and differences in spatial frequency could be explained also in light of the local combination detectors (LCDs) model recently proposed by Dehaene, Cohen, Sigman, and Vinckier (2005) which proposes that the visual recognition of words depends first on the detection of the local orienting bars, which are the basic components of the letters in a given case and shape. Hence, the vowelisation diacritics in the case of vowelised words are processed as detectors in addition to the word letters. This stage of processing does not exist in the case of non-vowelised words. Accordingly, processing the vowelisation diacritics produces a situation of prolongation of the visual recognition process.

It may be concluded from the results of the current study that vowelisation is needed for beginning readers during earlier stages of reading, where non-lexical processes are dominant. But, for reading familiar words and especially among older readers, vowelisation produces a situation of visual load and thus does not necessarily facilitate word recognition.

Disclosure Statement

No potential conflict of interest was reported by the author.

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