Assessment of Dyslexia in the Urdu Language

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are limited to certain cities and mostly cater to the elite of Pakistan. Teacher training is also inadequate; teachers are not familiarized with proper literacy instruction. The teaching methods are largely based on copying and memorization, and the attention to methods to enhance phonological skills is insufficient (Miles, 1998).

2.6.4 Limitations and Future Directions

Although it constitutes an important contribution to the assessment of dyslexia in Urdu, in its current state our test battery cannot be used as a stand-alone tool. Apart from the assessment of literacy skills, a comprehensive diagnosis of dyslexia requires other factors to be taken into account, such as academic achievement, family history, co-morbidity with other developmental disorders (e.g. ADHD or specific language impairment) and other functional skills (e.g. eye-hand coordination). However, the test can be used to identify core deficits associated with dyslexia (pertaining to reading and spelling skills) in young Urdu-speaking children. Since the test is user-friendly and administration requires minimal training (when accompanied by a training manual), the test battery can not only be used by health professionals (e.g. psychologists, speech-language pathologists, physicians) but also by elementary school teachers.

As we tested the battery in a sample of students from private middle-income schools only, generalization of the results is limited to this specific population. We deem it highly likely that our test can successfully be applied in other school types and children with different socioeconomic backgrounds but this warrants further investigation. An immediate future step is to standardize the test in a wider population to obtain age-appropriate norms.

Our test battery can support identification-assessment-remediation-feedback-training-and-monitoring intervention cycles. Response-to-Intervention (RTI) is one such comprehensive intervention model (Berkeley et al., 2009). RTI models consist of research-based, targeted strategies that are tailored to a student's individual needs and its response to instruction (Bender & Shores, 2007; NRCLD, 2007a) and include close monitoring as well as the active involvement of teachers and parents in the learning process. A validated diagnostic instrument can then play an important role at several stages in this cycle.

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Supplementary materials

The test materials are freely available on http://cdp-hf.org/.

CHAPTER 3

Reading Inconsistent Urdu Orthography: A Comparison of Typical and Struggling Readers

Abstract

Background: Urdu, a national language of Pakistan, belongs to the Indo-European family and has about 588 million speakers worldwide including around 100 million native speakers. Denoting short vowels, Urdu orthography is transparent when written with diacritics, leading to a one-to-one letter-sound correspondence, and opaque without them, when letters correspond to more than one sound. But what does this dual orthography mean for typical and struggling readers?

Aims: This study explores transparency and lexicality effects by comparing the reading performance of typical and struggling readers of Urdu on words with and without diacritics and words versus pseudowords.

Method: Children aged 7-11 years from grades 3-7 categorised as typical (n=167) or struggling readers (n=128) by their teachers and parents read aloud lists each containing: (1) 30 words with diacritics having one correct pronunciation, (2) the same words without diacritics having two or three correct pronunciations, (3) a list of different words without diacritics having a single correct pronunciation and (4), a list of pseudowords with diacritics having one correct pronunciation.

Results: All children read words without diacritics better and faster than those with diacritics and words better and faster than pseudowords. Reading accuracy and speed were significantly poorer in the struggling readers, and the length of words and their frequency also affected their performance more than it did the typical readers.

Conclusion: Both typical and struggling readers of Urdu rely more on visual word recognition rather than on letter-to-sound conversions, where a phonological deficit appears to explain reading-related issues in struggling readers.

Key Words: Inconsistent orthography, Urdu, diacritics, transparency effect, lexicality effect

3.1 Introduction

The first steps in learning to read in an alphabetic language involve transforming symbols (letters) into sounds, blending the sounds to form words and attaching meaning to them. This mapping of visual symbols to sounds is called phonological decoding. At a more advanced stage of reading acquisition, when with increased exposure word forms are stored in the word-form lexicon, they can also be accessed directly without breaking them up into sounds - a process which is referred to as direct word recognition. Thus, at a basic level, there are two main reading routes: the indirect and direct route. This dual-route hypothesis has been around for many years (e.g. Baron & Strawson, 1976; Baron, 1977; Forster & Chambers, 1973; Marshall & Newcombe, 1973), prompting Coltheart to propose his dual-route model (DRM) of reading in English in 1978 (see Figure 3.1). Having been extensively researched (Coltheart, Curtis, Atkins & Haller, 1993; Coltheart, Rastle, Perry, Langdon & Ziegler, 2001; Dijkstra, Grainger, & van Heuven, 1999; Morton & Patterson, 1980a; Morton & Patterson, 1980b) the DRM has been used to account for the process of reading in skilled as well as impaired readers (Perry, Ziegler & Zorzi, 2007; 2010).

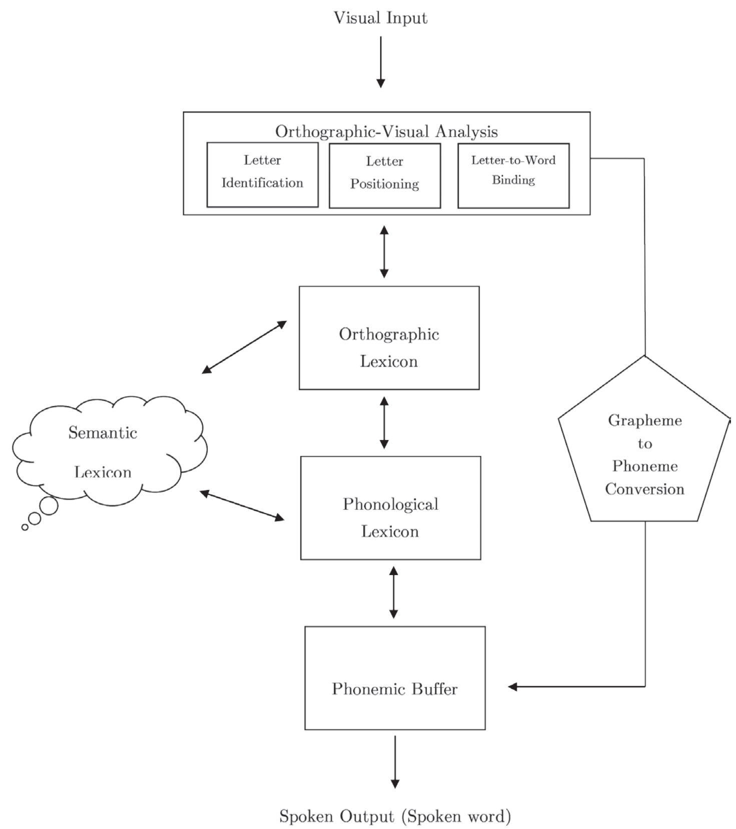

Figure 3.1: The components of the dual-route model of reading aloud (DRC Model - Coltheart, Rastle, Perry, Langdon and Ziegler, 2001. Figure 6, page 213)

According to the DRM, in the direct route the visual input is connected to the orthographic lexicon after orthographic-visual analysis, which can be used to read familiar words. The indirect route, involving the mapping of letters to sounds, must be used when reading unfamiliar or pseudowords and may be reverted to when reading familiar words. Studies have shown that words are read faster than pseudowords; this so-called *lexicality effect* is probably mainly caused by the direct word-recognition route being faster and more efficient than the phonological assembly route (Abu-Leil, Share & Ibrahim, 2014).

It has also been proposed that the reliance on each processing route is influenced by the consistency of a particular orthography (Frost, Katz & Bentin, 1987; Snowling, 2000; Ziegler & Goswami, 2005). Orthographies can be anywhere on the consistency continuum, from being transparent or shallow (one-to-one symbol-to-sound mappings) to opaque or deep (multiple letters mapping to a single sound or vice versa). At one extreme there are the Finnish and Turkish orthographies, which are very consistent in terms of letter-to-sound correspondences (Raman, Baluch & Besner, 2004; Raman, Baluch, & Sneddon, 1996). At the other extreme there is English, which contains many irregular words where letter-to-sound correspondences do not apply (e.g. ‘enough’) (Coltheart, 1978). A group of languages, namely the Arabic and Hebrew languages, have a dual orthography: they are transparent when vowel markers or diacritics are included and opaque when they are omitted from the written script (Koriat, 1984). Having compared the processing of words/pseudowords and high/low-frequency words in Hebrew, English and Serbo-Croatian, Frost et al. (1987) suggested the orthographic-depth hypothesis (ODH). In transparent orthographies like German, Finnish, Italian, and Spanish children learn to map letters to sounds faster than children learning opaque languages like English, French, Chinese, Arabic or Hebrew, which is termed the *transparency effect.* Transparent orthographies are easier to process through the indirect route compared to opaque orthographies where the reader processes the visual-orthographic structures of printed words because decoding words is relatively difficult. According to the ODH, readers tend to develop strategies to read opaque orthographies using the direct route and transparent orthographies via the indirect route. Beginning readers learn to read transparent orthographies relatively quickly, while in older children the direct route is better developed than in younger children (Baluch & Benser, 1991).

3.1.1 Reading the Dual-Orthography of Urdu

Urdu is an Indo-Aryan language and belongs to the Indo-European family (Everaert, 2009). It is the national language of Pakistan and one of the 23 official languages of India, having 100 million native speakers in these two countries alone, while there are around 588 million speakers of Urdu (along with Hindi) worldwide, making it the second most widely spoken language of the world (Ulrich, 2015). Yet, it still is an under-researched language.

In Urdu all words have regular letter-to-sound mappings when they are fully written out with vowel diacritics (Mumtaz & Humphreys, 2001), making the orthography consistent (transparent). However, it becomes inconsistent (opaque) as soon as these diacritics are

excluded, which is almost always the case in written materials intended for adult readers, given that skilled readers are able to discern the correct pronunciation of a word by looking at its context. As in Urdu there are many words with two or more pronunciations, beginning readers learn to read using diacritics as they specify the sounds and meanings of words. It is therefore essential for children to learn these vowel markers in order to distinguish the underlying phonology. The three short vowel diacritics or strokes are as follows: /ə/ symbolised by ‘◌َ’ placed above the consonant (بَ), /ɪ / symbolised by ‘◌ِ’ placed under the consonant (بِ) and /ʊ/ symbolised by ‘◌ُ’ placed above the consonant (بُ) as shown in Table 3.1.

Table 3.1: Short vowel diacritics

Vowel	Name	Transcription	IPA
◌َ	zabar	a	/ə/
◌ِ	zer	i	/ɪ/
◌ُ	pesh	u	/ʊ/

Note: dotted circle denotes the letter

For example تل can be read as تِل (/t ɪ l/ , pronunciation=til) meaning ‘mole’ and تَل (/t ə l/, pronunciation=tal) meaning ‘fry.’ The letter can hence only be read correctly if the diacritics are given or with the help of the context in which it occurs. To test whether a word is read via the whole-word recognition route, irregular words like “yacht” would be used in English, while in Urdu we use words without their vowel markers as these words cannot be read correctly unless the child is familiar with the word.

In order to explore reliance on different reading routes of the DRM within the Urdu orthography, we manipulated transparency and lexicality. By exploring visual-word recognition (also called lexical and/or direct) route and letter-to-sound conversion (also called non-lexical and/or indirect) route we hoped to be able to determine the processes children rely on most when learning to read Urdu, and whether these would differ between typical and struggling readers. In English, the purest measures of the visual-word recognition route are accuracy and speed when reading irregular words as these cannot be sounded out to produce a word and so must be read via the orthographic lexicon. An analogy to irregular words in Urdu is words without diacritics (non-diacritic words). Therefore, to index the functioning of direct route in Urdu we compared the accuracy and speed in reading words with and without diacritics. Words with diacritics (diacritic words) can be read either via the direct or the indirect route, words without diacritics are primarily read using the direct route. First, we selected non-diacritic words (having more than one correct pronunciation) and compared them with their diacritic version (with only one correct pronunciation due to inclusion of diacritics). Further, we compared the diacritic version of these words with another set of non-diacritic words with only one pronunciation.

To probe the use of reading routes further, we presented the children with words and pseudowords. As words can be read via the direct route and pseudowords cannot, a better performance on word reading, the lexicality effect, serves as an index of reliance on the direct processing. We further compared the performance of typical and struggling readers to see whether we would find distinguishing differences in the use of these routes in these groups.

In summary, to explore the effects of manipulations of the orthographic transparency of Urdu in beginning readers, we compared the accuracy and reading speed of *words with and without diacritics*, where words without diacritics had two manipulation levels: (1) words having more than one correct pronunciation and (2) words having only one correct pronunciation. To better understand the lexicality effects, we compared the accuracy and speed in reading *words and pseudowords*. Lastly, to explore potential differences in reading strategies, we compared the two effects in a large sample of typical and struggling young readers.

3.2 Method

3.2.1 Participants

As there was no standardised test for dyslexia available for Urdu at the time of our study, we had teachers and parents rate the reading performance of eligible students. This resulted in 295 children (150 boys), aged 7-11 years, attending grades 3 to 7 who were identified as typical readers (TR; n=167) or struggling readers (SR; n=128). All the children attended low-to-middle income private mainstream schools in Karachi, Pakistan, spoke Urdu as one of their primary languages of communication at school and at home and had received at least two years of formal reading instruction in Urdu (These were the same children as those participating in the previous study, for more details on the participants please see Chapter 2).

3.2.2 Materials

We selected 300 words from grade 3-7 school textbooks in Urdu, excluding compound words (mostly derived from Persian), words with heavy Arabic influence and commonly mispronounced words. We then selected a list of corresponding pseudowords matched for the number of syllables. Next, word frequency and age of acquisition were rated by the teachers of the participating children. Frequency was rated on a 3-point scale, with 1 denoting low and 3 high frequency. Both variables were subsequently independently rated by a group of 10 female and 10 male volunteers (18-80 years) having received a minimum of 12 years education. We selected the final test items based on the highest inter-rater correlations (frequency, Spearman $\rho = 0.81$, age of acquisition, Spearman $\rho = 0.83$). The selected words were all typically acquired before the age of 7 years.

The final test material consisted of four lists of 30 items each, three containing words and one pseudowords. To test the effects of vowel markers on reading, List 1 included one- and two- syllable words with diacritics, thus having only one correct pronunciation (henceforth referred to as 'same words with diacritics'); 15 were high-frequency and 15 low-frequency words. List 2 included the same words but now without diacritics, each having two (or three) correct pronunciations (referred to as 'same words without diacritics'). Examples are given in Table 3.2.

To assess the children's whole-word recognition skills, List 3 contained different words from Lists 1 and 2, all without diacritics and all having only one correct pronunciation (referred to as 'different words without diacritics'). Again, half of the words were high- and half low-frequency words. The words were ordered according to their length, with 10 words having one, 10 having two and 10 three syllables, where in each category half were high- and half low-frequency words. For example, see Table 3.2.

List 4 comprised 30 pseudowords, all with diacritics, thus having only one correct pronunciation (referred to as 'pseudowords with diacritics') and was administered to assess the children's knowledge of the relationship between Urdu letters and sounds as pseudowords cannot be read by whole-word recognition. The vowel markers were included to help the children read the word correctly, which was contingent on them knowing the correspondence rules. Ten words had one, 10 two and 10 three syllables. Examples are given in Table 3.2.

Table 3.2: Sample words from the four word lists presented for reading aloud

Lists	Condition	Sample words	Roman	IPA	English meaning
1	Words with diacritics	دُور	door	/ d uː r /	far
2	Same words without diacritics	دور	door/daur	/d uː r/, /d ɔː r /	far/era
3	Different words without diacritics	چاند	chaand	/ t͡ʃ ɑː n d̪ /	moon
4	Pseudowords with diacritics	بَتُش	batush	/ b ə t ʊ ʃ /	-

Note: Words with diacritics: 1 correct pronunciation; same words without diacritics: 2-3 correct pronunciations; different words without diacritics: 1 correct pronunciation; pseudowords: 1 correct pronunciation.

3.2.3 Procedure

The lists were presented one by one in individual sessions. The investigator instructed the children in each group to read the words of each list as fast and as accurately as possible (i.e. to try and prevent errors). For all four lists, reading accuracy was recorded in terms of the number of correctly read words, and reading speed as the number of seconds spent on reading a full list of 30 words.

3.3.4 Statistical analysis

Accuracy scores were analysed by ANOVA. As the analyses conducted with and without outliers yielded the same results, we did not exclude the outliers. Mauchly's test of sphericity indicated that the assumption of equality of variances was met (Field, 2009). Effect sizes (ES) are mentioned as partial eta squared (η_π^2) (small= .01, medium = .06, large = .14).

The *reading-speed* data were collected as the total number of seconds spent on reading a whole list of 30 words for all word lists. Therefore, reading-speed data could not be computed for word frequency and word length. Because the data had unequal variances and were not normally distributed, between-group differences were tested with Mann-

Whitney U tests. Analyses for within-group differences were carried out with the Friedman test. Results were expressed as effect sizes (ES) using Hedges' g (small = .2, medium = .5, large = .8, very large = 1.3).

We performed two separate sets of analyses, one for the transparency effect and one for the lexicality effect. For both, we first analysed accuracy and then reading speed. To determine the transparency effect, we compared lists 1, 2 and 3 (Table 3.2), running repeated measures ANOVA on the proportion (%) of correct responses with the within-subject factors Transparency (words with diacritics/same words without diacritics/ different words without diacritics), Frequency (high/low) and Length (short/long), and the between-subject factor of Reading Status (typical readers/struggling readers).

To explore the lexicality effect, we contrasted lists 3 and 4 (Table 3.2) using repeated measures ANOVA on the accuracy scores with within-subject factors Lexicality (different words without diacritics/pseudowords) and Length (1 syllable/2 syllables/3 syllables), and the between-subject factor Reading Status (typical readers/struggling readers).

3.3 Results

3.3.1 Transparency

3.3.1.1 Accuracy. The results for reading accuracy are given in Table 3.3.

All main effects were significant: words without diacritics (same and different) were read better than words with diacritics [Transparency, F (2,586) = 129.22, $p < .001$, $\eta_\pi^2 = .31$], as was the case for high-frequency words versus low-frequency words [Frequency, F (1, 293) = 390.87, $p < .001$, $\eta_\pi^2 = .57$] and shorter words compared to longer words [Length, F (1, 293) = 35.56, $p < .001$, $\eta_\pi^2 = .11$]. These factors were also significant across groups in that the typical readers performed better than their struggling peers in all conditions [Reading status, F (1, 293) = 271.57, $p < .001$, $\eta_\pi^2 = .48$]. Moreover, all interactions of transparency, frequency and length with reading status were significant, with consistently larger effects in the struggling readers than in the typical readers: [Transparency x Reading status, F (2,586) = 20.28, $p < .001$, $\eta_\pi^2 = .06$], [Frequency x Reading status, F (1, 293) = 23.42, $p < .001$, $\eta_\pi^2 = .07$] and [Length x Reading status, F (1,293) = 34.98, $p < .001$, $\eta_\pi^2 = .10$]. ES were large for transparency, frequency and reading status and medium for length and the interactions of transparency, frequency and length with reading status.

The transparency factor had three levels - words with diacritics, same words without diacritics and different words without diacritics. Same words without diacritics had more than one correct reading possibility and different words without diacritics had only one correct reading possibility. After finding the main effect of transparency we performed pair-wise comparisons and found that words without diacritics were read significantly better than words with diacritics, when the words were different in both conditions, *Mean Difference* = 9.97, *SE* = .88, $P < .001$, and also when the words were same in both conditions, *Mean Difference* = 11.77, *SE* = .74, $P < .001$.

Table 3.3: Reading accuracy results for words with and without diacritics for the two study groups

Transparency	**Frequency**	**Length**	**TR**		**SR**	
	High or low	**1 or 2 syllables**	M(%)	*(SD)*	M(%)	*(SD)*
Words with diacritics	High	1	95.09	*(11.81)*	56.72	*(32.14)*
		2	92.69	*(14.29)*	48.44	*(34.28)*
	Low	1	79.13	*(21.43)*	43.08	*(29.73)*
		2	81.59	*(19.68)*	34.47	*(30.08)*
	Overall		87.36	*(13.47)*	46.22	*(27.84)*
Same words without diacritics	High	1	97.54	*(9.34)*	71.72	*(29.78)*
		2	94.61	*(11.91)*	55.47	*(33.69)*
	Low	1	95.98	*(11.07)*	59.15	*(30.72)*
		2	94.39	*(12.09)*	56.54	*(31.09)*
	Overall		95.85	*(9.62)*	62.03	*(27.99)*
Different words without diacritics	High	1	98.32	*(8.04)*	74.06	*(30.15)*
		2	98.44	*(8.78)*	71.87	*(34.36)*
	Low	1	83.83	*(19.38)*	47.81	*(28.31)*
		2	88.02	*(18.37)*	48.59	*(31.42)*
	Overall		93.41	*(9.83)*	57.55	*(28.45)*

Note: *p < .001, accuracy = percentage of correctly read words, total no. of words per condition = 30; TR = typical readers; SR = struggling readers; words with diacritics = 1 correct pronunciation (list 1); same words without diacritics = 2-3 correct pronunciations (list 2); different words without diacritics = 1 correct pronunciation (list 3)

3.3.1.2 Reading speed. The results for reading speed are given in Table 3.4.

Table 3.4: Reading speed (in seconds) for words with and without diacritics for the two study groups

	TR n=167		**SR n=128**		**Difference in Means**
Condition	**M**	*(SD)*	**M**	*(SD)*	
Words with diacritics	62.18	*(40.80)*	137.02	*(80.54)*	74.84
Same words without diacritics	44.03	*(30.28)*	123.77	*(76.01)*	79.74
Different words without diacritics	52.76	*(43.81)*	159.91	*(101.06)*	107.15

Note: *p < .001, reading speed = time in seconds to read an entire list, total number of words per condition = 30; TR = typical readers; SR = struggling readers; same words with diacritics = 1 correct pronunciation (list 1), same words without diacritics = 2-3 correct pronunciations (list 2), different words without diacritics = 1 correct pronunciation (list 3). Higher mean indicates longer reading time.

Because the conditions for ANOVA were not met, reading speed was analysed with non-parametric tests. The between-group differences were significant in all conditions, all having large ES (g > 1), denoting that the struggling readers needed significantly more time to read the lists compared to the typical readers: words with diacritics, $U = 17631.50$, $z = 9.56$, $p < .001$, $g = 1.21$, same words without diacritics, $U = 18787$, $z = 11.15$, $p < .001$, $g = 1.45$ and different words without diacritics, $U = 19053$, $z = 11.52$, $p < .001$, $g = 1.44$. The within-group comparisons showed that the typical readers read the words without diacritics significantly faster than those with diacritics: same words, $\chi 2$ (2) = 1.09, $z = 9.93$, $p < .001$, $g = .50$, different words, $\chi 2$ (2) = .67, $z = 6.16$, $p < .001$, $g = .22$. The struggling readers also read the words without diacritics significantly faster than same words with diacritics, $\chi 2$ (2) = .44, $z = 3.56$, $p = .001$, $g = .17$. For words with diacritics and the different set of words without diacritics, the difference was in the opposite direction and not significant, $\chi 2$ (2) = .25, $z = 1.97$, $p = .15$, $g = .23$. ES for the within-group comparisons were all small (g < .3), except for the typical readers reading same words with and without diacritics, where the ES was medium (g = .5). Because of the opposite tendency for the two transparency comparisons, the interactions with reading status differed, where the comparison of words with diacritics and different words without diacritics interacted significantly with reading status, TR *Mean* = 9.42, *SD* = 30.11, SR *Mean* = 22.88, *SD* = 94.66, $U = 7560.50$, $z = 4.31$, $p < .001$, $g = .28$. The interaction between same words with and without diacritics and reading status, with differences in the same direction, was not significant, TR *Mean* = 18.15, *SD* = 26.73, SR *Mean* = 13.26, *SD* = 51.02, $U = 9928.50$, $z = 1.05$, $p = .29$, $g = .12$.

3.3.2 Lexicality

3.3.2.1 Accuracy. The results for reading accuracy are given in Table 3.5.

Table 3.5: Accuracy results for words and pseudowords for the two study groups

Lexicality	**Length**	**TR**		**SR**	
	(1, 2 or 3 syllables)	**M(%)**	***(SD)***	**M(%)**	***(SD)***
Words	1	91.08	*(11.77)*	60.94	*(26.51)*
	2	93.23	*(11.83)*	60.23	*(30.52)*
	3	95.75	*(11)*	51.48	*(35)*
	Overall	93.41	*(9.83)*	57.55	*(28.45)*
Pseudowords	1	93.47	*(10.75)*	48.82	*(32.08)*
	2	91.68	*(12.25)*	38.91	*(32.87)*
	3	88.92	*(15.25)*	25.55	*(31.42)*
	Overall	91.36	*(10.21)*	38.51	*(29.17)*

Note: *p < .001, accuracy = percentage of correctly read words, total number of words per condition = 30; TR = typical readers; SR = struggling readers; words without diacritics = 1 correct pronunciation (list 3) and pseudowords =1 correct pronunciation (list 4)

We found a main effect of reading status: the typical readers performed better than the struggling readers in all conditions [Reading status, F (1, 293) = 421.84, $p < .001$,

$\eta_\pi^2 = .59$]. We also found a main effect of lexicality: words were generally read better than pseudowords [Lexicality, F (1,293) = 125.15, $p < .001$, $\eta_\pi^2 = .30$]. The interaction effect between lexicality and reading status was significant, with the effect being greater in the struggling readers, signifying that the difference between pseudowords and words was larger in this group, [Lexicality x Reading status, F (1,293) = 83.49, $p < .001$, $\eta_\pi^2 = .22$]. The factor length also yielded significant main effect [Length, F (2,586) = 58.25, $p < .001$, $\eta_\pi^2 = .17$], with the interaction effects again being greater in the struggling readers, [Length x Reading status, F (2,586) = 58.59, $p < .001$, $\eta_\pi^2 = .17$]. The interaction between lexicality and length was also significant, [Lexicality x Length, F (2, 586) = 35.45, $p < .001$, $\eta_\pi^2 = .11$]. When we looked at the pattern, the difference due to word length was different for words and pseudowords. For pseudowords the trend for the two groups was the same in that all children read the shorter pseudowords more accurately than the longer pseudowords, with the difference being much larger in the struggling readers. As to word reading, we found the struggling readers read shorter words better than longer words while the typical readers read longer words better than shorter words, where the latter result indicates that in typical readers word-recognition skills appear to be highly developed. All ES were large, except for the interaction between lexicality and length, which had a medium ES.

3.3.2.2 Reading speed. The results for reading speed are given in Table 3.6.

Table 3.6: Reading speed (in seconds) for words and pseudowords for the two study groups

	TR n=167		**SR n=128**		**Difference in Means**
Condition	**M**	***(SD)***	**M**	***(SD)***	
Words	52.76	*(43.81)*	159.91	*(101.06)*	107.15
Pseudowords	107.74	*(65.41)*	196.42	*(101.09)*	88.68

Note: *p < .001, reading speed = time in seconds to read an entire list, total number of words per condition = 30; TR = typical readers; SR = struggling readers; words without diacritics = 1 correct pronunciation (list 3); pseudowords = 1 correct pronunciation (list 4). Higher mean indicates longer reading time.

The between-group non-parametric analyses yielded a significant difference for speed in reading words and pseudowords with large ES (g > 1), demonstrating that struggling readers needed significantly more reading time than the typical readers: words, $U = 19053$, $z = 11.52$, $p < .001$, $g = 1.01$, and pseudowords, $U = 16686$, $z = 8.26$, $p < .001$, $g = 1.07$. The within-group comparisons showed that all children read words significantly faster than pseudowords: typical readers, $\chi 2$ (1) = 5447, $z = 4.33$, $p < .001$, $g = .98$, and struggling readers, $\chi 2$ (1) = 13343.50, $z = 10.80$, $p = .001$, $g = .36$. The ES was large for the typical readers and small for the struggling readers. No significant interaction was found between lexicality (words versus pseudowords) and reading status, TR *Mean* = 54.98, *SD* = 47.18, SR *Mean* = 36.51, *SD* = 116.45, $U = 11667$, $z = 1.35$, $p = .18$, $g = .22$.

3.4 Discussion

In this study, we explored the transparency and lexicality effects of diacritics in 7-to-11-year-old typical and struggling readers of Urdu. The results showed that both groups read same and different words without diacritics (opaque orthography) better than words with diacritics (transparent orthography). The results are discussed in detail below:

3.4.1 Transparency

Comparing typical and struggling readers with respect to reading accuracy, we found that opaque words were read better than transparent words, high-frequency words better than low-frequency words, and shorter words better than longer words, with effects always being larger for the struggling readers. Regarding reading speed, the typical readers read the same-word and different-word lists without diacritics faster than the list that included diacritics. The results for the struggling readers were mixed; they read words without diacritics significantly faster than the same words with diacritics, but this effect was not significant when they read a different set of words without diacritics. This may be attributable to the difference in the length of the words that were presented (Schuster, Hawelka, Hutzler, Kronbichler & Richlan, 2016). The 30-item list comprising different words without diacritics included 10 three-syllable words, whereas the list of words with diacritics included one- and two-syllable words only. Since reading speed was measured for the whole list, this difference may have contributed to the struggling readers needing more time to reading the list with different words without diacritics.

The finding that in all children accuracy and speed were lower when they read words with diacritics than when they read words without these markers could be due to them being less familiar with the diacritic script. From grade 2 onwards, children are more exposed to and thus more familiar with reading material that does not include diacritics (Farukh & Vulchanova, 2014), while in the higher grades printed material no longer has diacritics. Also in their daily lives they are more exposed to non-diacritic print, as this is used on street hoardings, in newspapers and comic books, and in TV headlines. Print with diacritics hence becomes increasingly less familiar to children at an early age, which appears advantageous when they are asked to read non-diacritic texts.

Our findings for Urdu are consistent with previous research (Abu-Leil, Share & Ibrahim, 2014; Abu-Rabia & Siegel, 2003) on Arabic, which is orthographically similar to Urdu in terms of the usage of diacritic markers. Studying 13-15 year-old Arabic speakers attending public schools, Abu-Leil and colleagues (2014) found that the students made more errors and were slower when reading diacritic words than non-diacritic words. Asked to explain this effect, the children reported that, since the diacritic version was not the familiar version of Arabic (like in Urdu, Arabic diacritics are phased out gradually from early grades onwards), rather than facilitating them, the diacritics hindered them in their reading.

But why would diacritics hinder (young) readers of Urdu and similar diacritic languages? Researchers studying Arabic (Abdelhadi, Ibrahim, & Eviatar, 2011; Taha, 2008) earlier reported the same effects on reading accuracy and speed when they presented diacritic words. The authors proposed that the inclusion of diacritics makes the visual word forms orthographically complex and/or perceptually loaded compared to their non-diacritic cognates. Support for their explanation can be found in an eye-tracking study on Arabic-speaking university students (Roman & Pavard, 1987). They were asked to read sentences of about 95 words once with and once without diacritics, where the researchers found that the diacritics significantly increased the number and duration of fixations and gaze duration per word at the cost of reading speed. They attributed this delay to increased perceptual load, arguing that the presence of diacritics increases the complexity of the visual form of a word. Roman and Pavard (1987) further proposed that, apart from increasing the overall amount of visual information, the addition of diacritics might also interfere with adjacent letter(s), leading to visual crowding. The argument that both perceptual load and crowding negatively affect reading efficiency has also been put forward by other researchers (Khan & Buchanan, 2014; Pelli et al., 2006; Vogel, Woodman & Luck, 2001; Xu & Chun, 2006), while a study on Hindi/Urdu specifically states that the perceptual load of the Urdu orthography leads to processing difficulties (Rao, Vaid, Srinivasan & Chen, 2011).

Like Arabic, Urdu orthography can also be considered complex because of the multiple shapes of single letters and the number and positioning of dots on letters. Besides the role of diacritics, these additional orthographic features of Urdu and Arabic may also prompt a greater reliance on visual whole-word processing rather than on grapheme-to-phoneme associations. This argument was first proposed by Taha (2008, 2013) who examined the effects of various cognitive processing skills on the accuracy of reading diacritic words. He tested grade-6 speakers of Arabic using tasks involving naming and, phonological and visual processing and found significantly larger effects of visual processing skills on reading accuracy than of phonological processing skills. He explained this finding by proposing that in Arabic visual word recognition more heavily relies on visual processing skills than on phonological skills because of the specific orthographic features of the language. We did not have sufficient data to isolate the effects of perceptual load and/or visual complexity from grapheme-to-phoneme decoding processes in the present study, but propose further in-depth investigations with targeted stimuli to study the visual and phonological skills of the Urdu readers participating in our current study.

Another reason for the higher accuracy scores recorded for the words without diacritics compared to the *same words with diacritics* could be that all 30 words in the former list had two-to-three correct pronunciations and meanings. Both the typical and struggling readers thus had more options for a correct pronunciation of the non-diacritic words than they had for the diacritic words that had the single correct pronunciation only. Given the strong frequency effect we found, it may then be plausible that, each time, the children selected the most frequent candidate of the possible contenders from their lexicon. This word-recognition process could be explained in terms of parallel activation in that all the correct contenders are activated in parallel until one of the candidates reaches a recognition threshold (for a description of such models, see Seidenberg, 2012), whereby the higher frequency words that need less activation to reach this threshold will be favoured.

This strategy would result in correct responses for all 30 non-diacritic words. In contrast, in the same list of 15 high- and 15 low-frequency words that were presented with diacritics, parallel activation of other word forms could lead to interference. Thus, if a diacritic word is read, and the correct response is the less frequent one (in case of the 15 low-frequency words), then the frequency bias could result in a strong interference effect possibly even resulting in a fast but incorrect response, or a correct but delayed response. For example, the word بَلا (pronounced as bala, meaning hardship) is an infrequent diacritic variant of بلا.The other, frequent diacritic variant is بُلا (pronounced as bula, meaning call). Thus, while reading بَلا there will be interference from بُلا .

Considering our transparency results within the framework of the dual-route model (DRM) of reading aloud, we conclude that the reading profiles of the typical and struggling readers indicate that both groups relied more on the visual whole-word recognition route than they did on the letter-to-sound conversion route. Both groups performed better when reading words without diacritics than words with diacritics, where the difference was significantly larger in the struggling readers. Our findings are similar to those reported by Baluch and Danaye-Tousi (2006), who studied Persian[1]-speaking skilled and impaired readers (aged 9 years) and found that the impaired readers had greater difficulty in phonological processing than their skilled counterparts, resulting in more errors and lower reading speed for transparent words compared to opaque words. Given that the differences between diacritic and non-diacritic words were larger in the struggling readers, we can also infer that it is impaired readers that particularly experience problems with letter-sound coupling, as has also been found for Roman-alphabet languages where the core deficit concerns decoding. Our findings were further confirmed by the lexicality effect we observed when we compared word and pseudoword reading, the results of which we will elaborate on next.

3.4.2 Lexicality

The lexicality effect is an index of reliance on the visual word-recognition route - as words can be correctly read via this route but pseudowords cannot. In terms of accuracy, the effect of lexicality we obtained was significant: both groups read words better than they did pseudowords. Moreover, the performance of the struggling readers was significantly poorer than that of the typical readers. This also held for pseudoword length: both groups read shorter pseudowords more accurately than longer pseudowords, with the effect being larger for the struggling readers. These findings indicate a phonological decoding deficit in the struggling readers. Although the typical readers showed no such deficit, they also were less accurate and slower in reading pseudowords than words. Interestingly, the typical readers read longer words more accurately than shorter words compared to the struggling readers who read shorter words better than they did longer words, which appears indicative of fairly enhanced word-recognition skills in the typical readers. All the effect sizes were

[1]Persian or Farsi has a dual-orthography similar to Urdu. Urdu script was derived from Persian, which, in turn, was based on Arabic script.

large (ES $>$ .14), except for the interaction between length and lexicality, where ES was medium (ES = .11).

Regarding reading speed, the struggling readers needed significantly more time (ES $>$ 1) reading words and pseudowords than their unimpaired peers. Both groups read words faster than pseudowords, where the effect size was large for the typical readers (ES $>$ .9) and small for the struggling readers (ES $<$ .4). This greater ES for the typical readers again points to their enhanced word-recognition skills and a greater reliance on the DRM visual word-recognition route.

To explain the above results, we suggest that, since the words in the lexicality comparison did not have diacritics and thus had only one correct pronunciation, these words can primarily be read correctly via the visual word-recognition route, i.e. by directly accessing the whole-word information stored in the lexicon (Coltheart, 1978). The pseudowords, on the other hand, were presented with diacritics and could thus only be correctly read via the letter-to-sound conversion route involving phonological assembly. This process is considered to be less efficient and more time-consuming than the direct route (Coltheart, 2005). Our results are consistent with the Abu-Leil, Share, and Ibrahim (2014) study that tested the accuracy and speed on word-recognition tasks in 75 children aged 13-15 years. With words being read faster than pseudowords, they likewise found evidence of a lexicality effect. The authors concluded that the direct word-recognition route is faster and more efficient than the phonological-assembly route.

3.5 Conclusion

The overall findings of our study were that reading accuracy and reading speed in struggling readers were poorer in all conditions compared to typical readers.

Regardless of their reading proficiency, all children performed better and faster when reading non-diacritic words than when reading diacritic words, demonstrating the transparency effect, and when reading words rather than pseudowords, indicative of the lexicality effect. Both effects were greater in the struggling readers. Also, high-frequency words were read better than low-frequency words (frequency effect) and shorter pseudowords better than longer pseudowords (length effect) by both groups. Lastly, while the struggling readers read shorter words better than longer words, the reverse was true for the typical readers.

In terms of the dual-route model, our results indicate that typical as well as struggling readers primarily rely on visual word recognition rather than on letter-to-sound conversions. Diacritics are omitted from children's textbooks from as early as grade 2; our participants were 7-to-11 years old, corresponding to grades 3-7. It would be interesting to compare our two samples with 4-to-5-year-old peers to explore the preference of processing route at this early stage of reading acquisition in which these children are presented with the introductory reading book called 'beginning qaida' (see chapter 5 for detailed discussion).

Our findings further suggest that young struggling readers have specific difficulty with phonological processing (DRM's letter-to-sound conversion route), which is evident