Assessment of Dyslexia in the Urdu Language

Haidry, Sana

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Sana-e-Zehra Haidry

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Assessment of Dyslexia in the Urdu Language

PhD thesis

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on the authority of
the Rector Magnificus of the University of Groningen, Prof. E. Sterken,
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Disclaimer

This research work was undertaken to fulfil the requirements of International Doctorate for Experimental Approaches to Language And Brain (IDEALAB). The views expressed are those of the author and may not reflect the views of the Consortium.

Date: 05-12-2016

Signature..

Declaration

This thesis contains the work of the undersigned and to the best of my knowledge and belief, it contains no material previously published or written by any other person, except where due reference is given in the text.

Signed: Date: 05-12-2016

Dedication

I dedicate this thesis to my mother,

Without her it would not have been possible,

Without her I would not have been who I am,

Love you loads Ammaan!

—

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Contents

List of Tables

List of Figures

CHAPTER 1

General Introduction

1.1 Literacy Education in Pakistan

Situated in South Asia and bordering India, Iran, Afghanistan and China, the Islamic Republic of Pakistan has more than 188 million inhabitants, making it the sixth most populous country in the world (National Education Management Information Systems - NEMIS, 2015). However, only 2.5% of the country's total budget is spent on education, resulting in a 58% literacy rate[1], which is amongst the lowest in the world (Literacy rates of Education in Pakistan, 2015-16; United Nations Educational, Scientific and Cultural Organisation – UNESCO, 2016).

Wishing to learn more about reading processes and impairments amongst Pakistani school children, we ran a study in the city of Karachi, which is situated in the Sindh province, one of Pakistan's eight administrative units. Karachi is the capital of Sindh and also the industrial hub of the country. With its population of over 24 million people (Khawaja, 2013; Thomas, 2015), it is the seventh most populous urban city in the world (World Atlas, 2016) and the second largest in the Muslim world (Maps of World, 2016).

Being a developing country, Pakistan is confronted with a host of problems like

[1] being able to read and write at basic level

high levels of health issues and poverty, high unemployment rates and political instability. Illiteracy is seen as one of the major causes of these difficulties. Gaining access to (quality) education and sustaining school attendance is a challenge for many Pakistani children. Although the current primary school population in Pakistan is estimated at over 21 million, about 5.5 million children do not attend school (The Express Tribune, 2016). The primary-school enrolment rate is 69% but 33% of these students do not make it to grade 5 (i.e. the end of the primary phase; Pakistan Education for All Review Report, 2015). Consequently, two-thirds of Pakistan's primary schoolchildren do not acquire basic or age-appropriate literacy skills. The Pakistani government now acknowledges, and is striving to overcome these nationwide educational problems. Article 25A of the 18th amendment to the constitution of Pakistan ensures all children aged 5 to 16 years the right to free and compulsory education (Pakistan Education for All Review Report, 2015). The conceptual understanding of the importance of literacy and education has prompted many governmental initiatives. Pakistan is the signatory of Education For All (EFA) goals, a global initiative led by UNESCO to fulfil the learning needs of children (Pakistan Education for All Review Report, 2015; World Education Forum Dakar Framework for Action, 2000). Pakistan also strives to achieve universal primary education as part of the Millennium Development Goals (MDGs) of the United Nations Millennium Declaration (United Nations Development Program-UNDP, 2016).

Pakistan has a complex educational system similar to those found in other post-colonial countries (Kizilbash, 1995). There are various types of schools such as government-run public schools and private-sector schools. Schools differ in terms of the quality of education they provide and the availability of educational resources (Ali et al., 1993). The target population we focus on in our study attends middle-income private schools, which cater to around 17 million students in Pakistan (NEMIS-Pakistan Education Statistics, 2014). Educational levels are as follows: a pre-primary phase corresponding to nursery and kindergarten level for 3-4-year olds; a primary phase corresponding to grades 1-5 for children aged 5-9 years; a middle phase including grades 6-8 for pupils aged 10-12 years; and finally a higher phase including grades 9 and 10 serving students aged 13-14 years.

The reading and spelling skills of primary-school children in Pakistan are alarmingly low. One third of Pakistani children completing the primary phase of their education are struggling with reading and writing. It needs to be noted here that both English and Urdu are used as instructional languages in Pakistan's middle-income private schools. About 49% of grade-3 and 45% of grade-5 students cannot read or connect sentences meaningfully in English (Annual Status of Education Report - ASER, 2013). The statistics do not get any better when we consider reading and writing in Urdu, which is not only the national language of Pakistan but also the primary language of instruction and communication at home and in the middle-income private schools. Early Grade Reading Assessment results (EGRA, 2014) showed that only 4% of the third-grade and 18% of the fifth-grade readers were able to comprehend grade-3 level written material in Urdu (Pakistan Reading Project of United States Agency for International Development-PRP USAID, 2013-2018). Such low levels of reading proficiency in both languages call for a better understanding of the reading process, especially in Urdu.

1.2 Theoretical Perspective

There are no theories or models proposed for the reading process in Urdu, however since Urdu is an alphabetic orthography, theories and models of reading that have been developed for alphabetic orthographies such as English may be the most appropriate ones to be applied to Urdu. One such model proposed for the English language is the dual-route model (DRM) for reading (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). The dual-route model of reading (aloud) has the advantage that it is not only applicable to 'normal' reading but also to 'impaired' reading - dyslexia, both developmental and acquired (Sprenger-Charolles, Siegel, Jiménez & Ziegler, 2011). Developmental dyslexia is impairment in learning to read and involves children who have difficulty attaining age-appropriate reading skills, while acquired dyslexia refers to reading deficits caused by brain damage, thus involving the loss of reading ability in formerly literate individuals. The focus of our study is on developmental reading impairments or developmental dyslexia. In this dissertation we will adopt the definition of developmental dyslexia given in the latest Diagnostic and Statistical Manual (DSM-5), where dyslexia is described as a "pattern of learning difficulties characterized by problems with accurate or fluent word recognition, poor decoding, and poor spelling abilities" (American Psychiatric Association, 2013).

1.2.1 The reading process. Theories of reading in English propose that skilled reading involves the rapid, effortless and automatic decoding of words, involving word recognition, comprehension and fluency. To become a proficient reader, one is required to identify printed words (word recognition), attach meaning to them (comprehension) and then coordinate these abilities skilfully to optimize reading efficiency. Accurate and fluent reading is dependent on certain early acquired abilities such as alphabetic knowledge and letter-to-sound mapping skills. Children learning to read in an alphabetic writing system must first learn to associate letter shapes with their names and the sounds they represent. Next, it is of paramount importance that they learn that the letters in written words correspond to the particular sounds of spoken words (decoding) and that these units of sounds can be blended together to form a word. After some exposure and practice, they will then be able to read the word instantly as a whole without having to break it down into units of sound (Ehri, 1995).

Skilled reading of English occurs through the co-ordinated use of specific and intertwined orthographic and phonological systems. According to the dual-route model (Coltheart, 1978; Colhteart, Curtis, Atkins & Haller, 2001), there are two basic ways to read aloud words in English. The reader either breaks down the word by attaching the right sounds to each letter or grapheme and then blending the sounds together to arrive at the pronunciation of the word (decoding), or (s)he identifies the whole word at one glance, i.e. immediately perceives the visual word form (sight reading) (Pritchard, Coltheart, Palethorpe & Castles, 2012). These two distinct processes do not necessarily function in isolation but mostly occur simultaneously depending on the nature of the printed material. Decoding skills can best be assessed by presenting pseudowords (e.g. deehan), while sight-reading abilities are evaluated by offering irregular words (e.g. enough, yacht). Throughout this thesis, Urdu reading processes and impairments have been examined through the application of the dual-route model to Urdu reading. In the next section, the DRM as originally proposed for English is outlined in detail, and then its application to Urdu is considered.

1.2.2 The Dual-route model (DRM) of reading. The DRM explains the processes involved in reading words in terms of functional units consisting of different subcomponents and pathways connecting these subcomponents. Impaired reading can then be explained through different functional deficits in any of these components and/or pathways, each indicative of a subtype of dyslexia. The pictorial representation of the DRM is illustrated in Figure1.1.

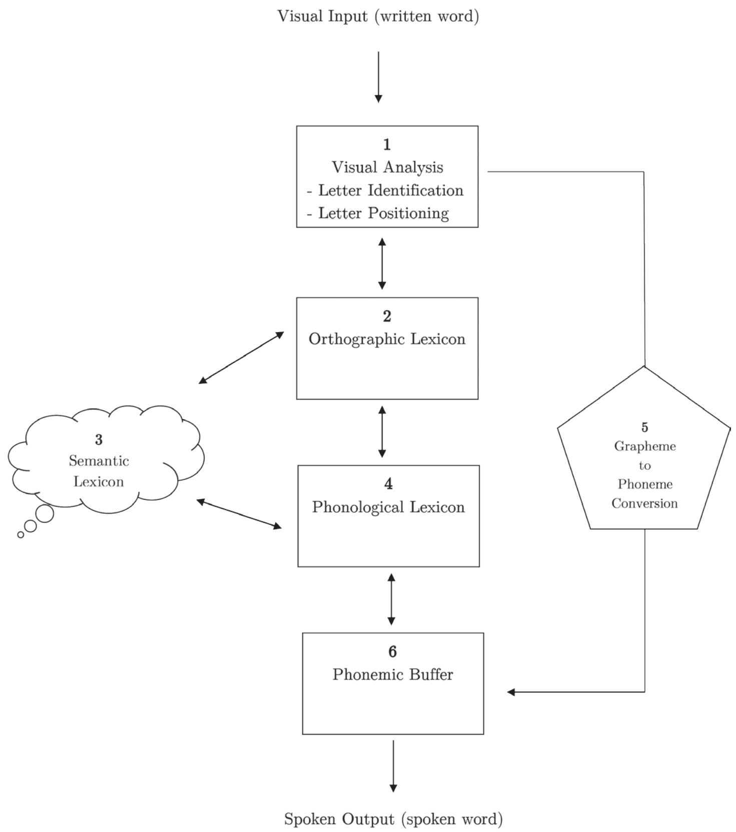

Figure 1.1: The components of the dual-route model of reading aloud (DRC Model - Coltheart, Rastle, Perry, Langdon & Ziegler, 2001, Figure 6, page 213)

The first DRM component is visual analysis (Figure 1.1, Component 1) involving the identification and positioning of letters. Deficits in this area manifest in letter-identification issues such as confusing ‘p’ with ‘q’ and letter-positioning issues such as reading ‘spot’ in place of ‘stop’. These conditions are known as letter identification dyslexia and letter position dyslexia respectively.

After the visual-analysis stage, the model divides into two routes, the *lexical route* (also known as *whole-word recognition* and/or *direct* route as well – terms used interchangeably throughout the thesis) and the *non-lexical* route (also known as *letter-to-sound conversion* and/or *indirect* route as well – terms used interchangeably throughout the thesis). The lexical route is a stored memory system for known written words. The first component along this route is the orthographic lexicon (Figure 1.1, Component 2) which ‘recognizes’ the word from its orthographic form if the word form is familiar to the reader, but it may also respond to pseudowords by activating visually similar words (e.g. ‘bin’ for ‘din’). This passes down to the semantic lexicon (Figure 1.1, Component 3), which recognizes and activates the correct meaning of (familiar) words stored in the mental lexicon, and, if impaired, causes one to read without comprehension. The phonological lexicon (Figure 1.1, Component 4), contains information about the spoken form of known words. Impairment of any component along the lexical route affects word reading skills, and specifically the reading of irregular words such as *yacht* whereas pseudoword reading abilities remain intact, a condition called developmental surface dyslexia (Castles & Coltheart, 1996).

The other main pathway to reading aloud, the non-lexical route, is most heavily relied on by young children starting to read, as their orthographic lexicon is as yet limited. However, even skilled readers must rely on output from this route in order to successfully read new or unfamiliar words. The grapheme-to-phoneme conversion component (Figure 1.1, Component 5) involves the direct transformation of recognized letters into auditory-articulatory speech sound representations without tapping into the orthographic input lexicon. If this route is selectively impaired, children will have problems processing pseudowords while their ability to process words, both regular and irregular, is not affected, the condition termed as developmental phonological dyslexia (Castles & Coltheart, 1993).

Finally, the sixth and final component of the DRM comprises the phonemic buffer (Figure 1.1, Component 6), is shared by the lexical and non-lexical routes. This component allows speech sounds to be stored in short term memory in preparation for spoken output.

1.3 The Urdu Language

Urdu is an Indo-European, Indo-Iranian, Indo-Aryan language, is Pakistan’s national language and one of the official languages in India. There are over 60 million native Urdu speakers in Pakistan, while around 100 million Pakistani speak Urdu as their second language. Because of the large South-Asian Urdu-speaking diaspora, it is also widely spoken in the United Kingdom, United States, Canada, Australia and the United Arab Emirates among other countries (Humayoun, 2006).If we combine speakers of Hindi with those speaking Urdu, Urdu becomes the second most spoken language in the world (Grimes, 2000; Rahman, 2004; Ulrich, 2005).

Spoken Urdu and Hindi are quite similar, but orthographically they are completely different. Urdu is orthographically similar to Arabic which is cursive in nature and written from right to left. Other common features of Urdu and Arabic are the use of diacritics to denote short vowels and that letters change shape according to their position in a word. Urdu is written in Persio-Arabic script, while Hindi uses the Devanagari script derived from Sanskrit. Urdu developed under the influence of Persian, Arabic and Turkish rule in the course of almost 900 years. The word 'Urdu' itself is derived from the Turkic word 'oordou' which means 'camps' or 'armies' (Abbas, 2002). In terms of usage, Urdu has diglossia[2]. The informal version is known as a 'rough mixture' (ریختہ), while the more proper version of Urdu is called 'Language of the Exalted Camp' (زبانِ اردو مُعلّیٰ) (Colin, 1993). The words selected in the spoken language reflect the etiquette being followed. For instance, the words **'آب'** (āb) and **'پانی'** (pānī) both mean water, where the former word is the more refined of the two. Moreover, because some vowels are considered distinct letters and some letters only very rarely appear in words, researchers disagree about the total number of letters in the Urdu alphabet (Afzal & Hussain, 2001). In our study, we have included 40 letters and three diacritics (denoting short vowels) commonly introduced, taught and used at primary level. Moreover, Urdu has a complex vowel system and the distinction of consonants and vowels is also vague.

Urdu has some distinctively interesting features that need to be taken into account to better understand skilled and impaired reading in Urdu. First, many letters are visually similar and can only be differentiated in terms of presence, number and position of dots and/or strokes {e.g. ج (/d͡ʒ/) , چ (/t͡ʃ/) , ح (/h/, /ɦ/) and خ (/x/)}. Second, one sound is represented by more than one letter (e.g. /s/س ، ص ، ث and /z/ ز ، ذ ، ض ، ظ). Third, it uses diacritics, that is, three short markers that are placed above and below letters to denote short vowel sounds. The inclusion of diacritics makes Urdu orthographically consistent. However, the markers are omitted from grade 2 (6 years) onwards, rendering the Urdu script opaque at that point. Because of its dual orthography, Urdu is an interesting language in which to study orthographic depth. The three short vowel diacritics or strokes are as follows: /ɪ/ symbolised by ' ◌ِ ' placed under the consonant بِ /ʊ/ symbolised by ' ◌ُ ' placed over the consonant بُ and /ə/ symbolised by ' ◌َ ' placed above the consonant بَ. Although, as alluded to above, they are rarely used in written material intended for adult speakers, beginning readers of Urdu learn to read with these vowel diacritics, making Urdu orthographically shallow. There are many words in Urdu that share the same spelling patterns without diacritics, but vowel diacritics alter both their sound and meaning (e.g. دُور meaning *far*, is pronounced as '*doore*' and دَور meaning *era* is pronounced as '*daur*'). Fourth, Urdu letters can acquire up to four shapes depending on their initial, medial, final or isolated position in a word. For example the letter Yeh 'ی' has four shapes: یـ, ـیـ, ـی, and ی.

[2] Urdu has two varieties; one is a common variety (also referred to as easy Urdu) which is used by people in their everyday lives, and second variety is used in literature, formal education, or specific situations, but not commonly used for ordinary conversation (also known as hard Urdu).

1.3.1 Urdu reading process and impairments. Applying the DRM to Urdu, an alphabetical language similar to English, we expect to find comparable reading difficulties in Urdu-speaking children that pertain to the various DRM components, and identified using different targeted reading measures of each component. In this section, we focus on how these impairments in components could manifest themselves in Urdu and further how they can be assessed in Urdu.

Deficits in the first component - visual analysis (Figure 1.1, Component 1) – would be expected to manifest in letter-identification issues such as confusing 'پ' with 'ث' and letter-positioning issues such as reading **'کاٹنا'** in place of **'کانٹا'**. These deficits can be assessed by tasks involving identification of letter-name knowledge and reading of word-pairs with specific manipulation of letters to gauge letter migrations within a word.

Next, the model divides into the two parallel processing routes; the lexical route, which consists of orthographic lexicon (Figure 1.1, Component 2), semantic lexicon (Figure 1.1, Component 3) and phonological lexicon (Figure 1.1, Component 4), and the non-lexical route which involves letter-to-sound conversion (Figure 1.1, Component 5). In Urdu, a manifestation of impairment in lexical route would be misreading words without vowel diacritic markers – opaque or irregular words (e.g. **'چاند'**, correctly pronounced as 'chaand' being misread as **'چا - ند'** pronounced as 'cha - nad'). This is because these words cannot be read aloud correctly without stored lexical knowledge of the visual form of the word and its corresponding pronunciation. Manifestations of impairment in non-lexical route would be misreading a pseudoword as a familiar word (e.g. reading **'بول'** meaning words for **'نول'** which is a pseudoword). The sixth and final component (Figure 1.1, Component 6) comprises the phonemic buffer, which allows speech sounds to be identified and synthesized into words. Deficits in this component can be assessed through phoneme deletion tasks or other working memory tasks (these impairments and assessment tasks have been extensively discussed in Chapter 2, which covers the development of assessment battery for dyslexia in Urdu).

Reading difficulties are heterogeneous in nature in that not all children with dyslexia will exhibit the same set of symptoms; different combinations of deficits related to specific components within the impaired route can occur. Comprehensive and early assessment of all aspects of deficient reading abilities and targeted, tailored remediation are essential. Still, despite the increased awareness of the severe impact of literacy problems and the growing interest in improving the reading skills of children in Pakistan, no assessment tool has been available for Urdu. The motivation for the present study then arose from the need to provide researchers, schoolteachers and allied professionals (speech-language therapists) with such a dedicated assessment tool to help them determine the underlying basis of poor reading in young readers. In the following chapter, we have described our research efforts, outlining our choice of tests and validating our Urdu-specific dyslexia battery.

1.4 Overview of the Thesis

In the above sections we have established the need for the thorough assessment of reading difficulties in Urdu. We have also explained why and how we can adopt the dual-route model of reading to assess Urdu reading processes and impairments. **Chapter 2** covers the development and validation process of our Urdu reading/dyslexia test battery. The broad aim of this first study was to try and understand the nature of typical and impaired reading processes in the Urdu language. Our specific objectives were: (1) to develop a test battery to assess the ways in which reading impairments present in Urdu; (2) to understand the patterns of deficits of key reading processes in Urdu by comparing and profiling young struggling readers and typically developing age peers; and (3) to test the application of the dual-route reading model (DRM) to Urdu. The choice for and content of each individual test is described in detail as well as their validity and reliability, along with the results of our group comparisons (typical vs. struggling readers).

Apart from the fact that Urdu is spoken by more than 500 million people around the world, it still is an under-researched language. Certain features of Urdu, such as its dual orthography and the fact that alphabetic letters can change shape according to their position in a word (the letter-position effect), make it an interesting language to study. In **Chapter 3** we elaborate on the dual-orthography aspect by studying the effects of inconsistencies in the Urdu orthography due to the presence and absence of diacritics or short-vowel markers. We investigated the transparency and lexicality effect, and the application of the dual-route model by exploring which of certain presented words are read more accurately and which faster, namely (a) words with or without diacritics and (b) words or pseudowords. We again sought to gauge the difference between typical and struggling readers in terms of reading performance and reading speed.

Chapter 4 revolves around the letter-position effect. In the study presented we sought to understand the effect of the Urdu orthography on letter-position processing in beginning readers. As alluded to above, an intriguing aspect of the Urdu orthography is that many letters change their shape according to their position in a word. We examined reading accuracy with the hypothesis that scores would be higher for words with changed-shape migrated-letter cognates as compared to when the shapes of the letters remain the same. We expected this to be true for both the typical and the struggling readers but more so for the latter group. We additionally investigated word-frequency effects and differential effects between migrations of initial and final letters compared to migrations of middle letters.

The thesis concludes with a discussion of all the studies in **Chapter 5**, where also future directions in the field are proposed.

CHAPTER 2

Assessing Dyslexia in the Urdu Language

Abstract

Background: As in Pakistan tests to diagnose reading and spelling impairments are mostly based on English tests, there is a dire need for a dedicated test battery that assesses these basic skills in the Urdu language in the early stages of reading acquisition to thus allow timely identification and remediation of any deficits.

Aim and Method: To develop and validate a test battery to identify reading disability (dyslexia) in young children mastering the Urdu orthography. Based on dual-route model (DRM) of reading (in English) and dyslexia batteries in other alphabetic languages, tests for letter knowledge, word and pseudoword reading and spelling, and phonological abilities were constructed and administered to 167 typical readers (TR) and 128 struggling readers (SR) aged 7-11 years (grades 3-7; 150 boys, 145 girls) to establish the tests' reliability and validity, create profiles of the reading-related cognitive functions of proficient and struggling readers and test the applicability of dual-route model to Urdu.

Results: Test reliability was very high. Content validity was substantiated through the high correlation between two independent ratings. Overall, correlations of accuracy and speed measures confirmed the test battery to have high construct validity. All TR-SR differences were significant ($\alpha = .01$) in detriment of the SR group. Effect sizes (ES) were the highest for the spelling measures ($g > 2$), followed by the reading measures, where ES for accuracy ($g > 1.50$) were higher than those for speed ($g < 1.50$) and ES for pseudoword reading and spelling ($g > 2.5$) higher than those for word reading and spelling ($g = 1.59$-2.37). The medium ES for rapid automatized naming (RAN) and vocabulary were lower than those for reading and spelling.

Conclusion: The developed test battery based on DRM was reliable and valid, and differentiated well between TR and SR which can be interpreted as DRM being applicable to Urdu's dual orthography as well.

Key words: assessment, dyslexia, Urdu, dual-route model, dual orthography, reading, spelling

2.1 Introduction

Urdu, one of Pakistan's national languages, is the second most spoken language in the world (Grimes, 2000; Rahman, 2004; Ulrich, 2015). Despite having 588 million speakers including 70 million native speakers (Lewis et al., 2016; Ulrich, 2015), it still is a very much under-researched language (Farukh & Vulchanova, 2014). Hence, the nature of reading processes in Urdu and reading impairments, such as dyslexia, are not yet fully understood nor studied in-depth, which is an important reason why struggling readers are not properly identified, assessed or remediated in Pakistan. This paucity creates a vicious cycle of negative consequences such as academic underachievement, relatively low national education levels and un(der)employment, which potentially affects quality of life (Qin, 2016; Schulte-Körne & Bruder, 2010).

In Pakistan around six million children are deprived of quality education (Education for All, 2015). The most common barriers include high illiteracy rates, poverty, gender discrimination, a lack of training, low salaries and high workload for teachers (National Education Management Information System Pakistan-NEMIS, 2012-13). Spending less than 3% of the national budget on education, the Pakistani government appears negligent to these problems (Naeem, Mehmood, and Saleem, 2014). It is, accordingly, hard to determine whether children's reading problems in Urdu emanate from a lack of attention and available resources at school or a high prevalence of illiteracy in the family, or whether they can be attributed to dyslexia.

Note that in this study, unless indicated otherwise, we adopt the DSM-5 definition (American Psychiatric Association, 2013) for developmental dyslexia, being a specific learning disorder characterized by problems with accurate and/or fluent word recognition, decoding, and spelling abilities, and being distinct from reading and/or spelling difficulties caused by poor or inadequate instruction or an impoverished home environment (Snowling, 2000; Stanovich, 1988).

An exact dyslexia prevalence rate for Pakistani children is not yet available. Of all persons with disabilities in Pakistan, an estimated 25% are children aged 5-14 years (United Nation's Children Fund- UNICEF, 2003) of whom only 2% had access to special schools (Bureau of Statistics, 1998; Shahzadi, 2000). Screening 200 primary schoolgirls (grades 3, 4 and 5) for specific learning disorders (as based on DSM-5 criteria), Irshad (2005) concluded that 75 met the criteria, while the author also observed high rates of emotional problems such as depression, anxiety, lack of confidence and poor self-image. Ashraf and Majeed (2011) assessed 250 boys and 250 girls (aged 11-17 years) attending grades 6, 7 and 8 of Pakistani government schools and found 5% of the students to meet the DSM-5 diagnostic criteria for dyslexia.

It is widely accepted that early identification of dyslexia and timely remedial intervention are crucial for the academic outcome of individuals facing these learning difficulties in their childhood (Rothenberger, 2005; Stanovich, 1986; Webster-Stratton and Taylor, 2001). Previous studies have clearly shown that timely remediation positively affects children's reading skills, potentially preventing future problems such as un(der)employment (Bradley, 1988; Clay, 1991). Unfortunately, in the absence of a proper assessment battery for dyslexia in Urdu, tests developed for English are used without validation for Urdu. These tests do not assess phonological and orthographic specificities of Urdu. In a review of the literature, we did not find a single test for Urdu that can reliably distinguish between children with dyslexia and typically developing children.

Although a reading and writing comprehension test for Urdu has been developed for secondary schoolchildren (Khan et al, 2011), no tests have been designed to assess reading-related processes, such as letter and sound knowledge, letter-to-sound association (decoding), sound blending, whole-word recognition, vocabulary, spelling (encoding) and rapid naming (fluency). Moreover, most research has focused on older children (Ashraf and Majeed, 2011; Irshad, 2005; Khan et al, 2011; Naeem, Mahmood & Saleem, 2014), while assessments conducted in the early stages of reading acquisition are vital to identify dyslexia and initiate remedial interventions early. Furthermore, although researchers strongly advocate the use of culturally fair tests to obtain a reliable diagnosis of dyslexia, the tests currently used in Pakistani schools are all developed in Western countries (Naeem, Mahmood & Saleem, 2014).

In the present study, we seek to fill this gap in knowledge through targeted tests. We present and test a tool to assess reading and spelling in young Urdu-speaking children that discriminates struggling readers from typically developing peers and helps identify children with dyslexia at an early stage. Assessing dyslexia in a language with a deep orthography calls for a different method than in a language with shallow orthography (Masterson, 2000). Urdu is exceptional in this regard as it has a dual orthography: both deep and shallow, depending on the absence and presence of diacritics[1] respectively. This specific characteristic makes Urdu an interesting language to study in the context of models of reading. Since Urdu and English are both alphabetic languages and there is no dedicated reading model for Urdu, we largely based our dyslexia battery on the dual-route model (DRM) of reading (Coltheart, 1978), which has been shown to be applicable in most alphabetic languages (Levy et al., 2009; Ziegler, Perry & Coltheart, 2000), and does not only account for normal reading processes but also impaired reading and dyslexia. We aim to test the applicability of DRM to Urdu with our newly developed assessment tool, to contribute to a better understanding of the nature of reading processes and reading impairments (dyslexia) in Urdu. Urdu is an Indo-Aryan language having 40 letters; it is orthographically similar to Arabic and Persian, cursive in nature, and written from right to left.

Orthographies of languages can be classified on a continuum from shallow (one-to-one letter-sound correspondence) to opaque (multiple letters corresponding to more than one sound). This transparency of letter-to-sound mapping is called orthographic depth (Ziegler & Goswami, 2005). As mentioned before, Urdu has fluctuating orthographic depth due to the inclusion and exclusion of diacritics. It has regular spelling-to-sound correspondences when fully written out with diacritics but when diacritics are missing successful word identification happens with contextual help (Mumtaz and Humphreys,

[1] Diacritics are three short vowel markers in the form of strokes placed above and/or below the letters. These 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.

2001). Usually, diacritics are omitted in reading materials for adults and from children's reading books from grade 2 onwards (Rao et al., 2011). Another interesting aspect of Urdu is that letters change their shape according to their position in a word. For instance, the isolated form ‘غ’ (/ɣ/) can be written as غـ, ـغـ and ـغ in initial, medial and final positions, respectively. Investigating reading acquisition in young children can provide more insight into how inclusion or exclusion of diacritics and letter positions affect normal and impaired reading processes in Urdu. We developed assessments of the strengths and weaknesses of beginner readers based on the functionality of particular components and/or pathways of the dual-route model (DRM - see Figure 2.1).

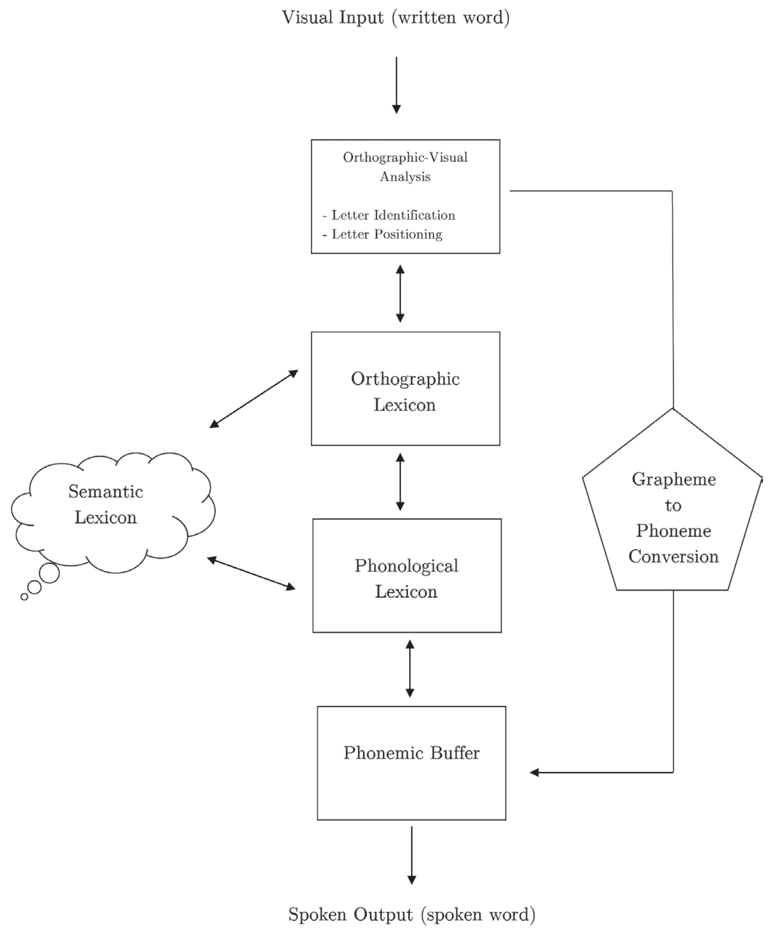

Figure 2.1: The components of the dual-route model of reading aloud (DRC Model - Coltheart, Rastle, Perry, Langdon & Ziegler, 2001, Figure 6, page 213).

2.1.1 Theoretical Perspective – Dual-Route Model (DRM)

According to the DRM, there are two separate routes for reading aloud: letter-to-sound conversion or indirect route, and visual word recognition or direct route. In the indirect route letters are converted into phonological representations. Pseudowords (e.g. 'lat', 'gat') and novel words are primarily read through this route. In the direct route, the reader recognizes the visual word form of the whole word without performing letter-to-sound conversions. Irregular words (e.g. 'enough') and familiar words are primarily read through this route. Successful reading then requires the two routes to be applied proficiently. Malfunction of any of these processes will lead to specific reading issues (Coltheart, 2005). If the development of the orthographic lexicon is impaired, for instance, this can lead to errors in reading irregular words while reading regular words and pseudowords would be unaffected, a disorder which is known as surface dyslexia (Castles and Coltheart, 2013; McDougall, Borowsky, MacKinnon & Hymel, 2005) If, conversely, letter-to-sound conversion is impaired, this will elicit errors in reading new words and pseudowords, a disorder which is commonly labelled as phonological dyslexia (Castles and Coltheart, 2013; McDougall, Borowsky, MacKinnon & Hymel, 2005). If the impairment occurs at an earlier processing stage, such as at the level of orthographic-visual analysis, this will produce errors in letter identification and letter-position coding (Kezilas et al, 2014). Having multiple letter forms for each letter, Urdu might seem more difficult in some respects than English. Then again, letters that have different shapes in initial, middle and final positions, facilitate in word recognition and thus potentially reduce the frequency of letter position errors (Friedmann and Haddad-Hanna, 2012).

To enable us to successfully identify reading disabilities in children first learning to read Urdu, we took the DRM and existing dyslexia batteries for other alphabetic languages as our starting point. We constructed Urdu-specific tests to assess letter knowledge and word and pseudoword reading and spelling, as well as tests gauging phonological abilities, since these are the most prominent reading-related functions according to the definition of dyslexia adopted by the International Dyslexia Association (IDA; Lyon, Shaywitz and Shaywitz, 2003). To determine its reliability and validity, the test battery was administered to a large group of typical and struggling readers. Then we compared the reading and spelling performance as well as the profiles of reading-related cognitive functions of the typical and struggling readers. Since there was no theoretical model available for Urdu, we largely based our test battery on DRM. As Urdu is an alphabetical language similar to English, we expected to find comparable reading difficulties in Urdu-speaking children pertaining to the various DRM components, which can be identified using different targeted reading measures for each component.

2.2 Method

This research was ethically approved by the Macquarie University Human Research Ethics Committee (Australia, Reference No. 5201300826) and by the Research Ethics Committee (CETO) of the Faculty of Arts of the University of Groningen (The Netherlands). Informed consent was available for all the children.

2.2.1 School and Participant Selection

Mainstream schools in the city of Karachi were sent letters informing them about our study, while orientation meetings were arranged for staff from interested schools. From these, we selected three private middle-income schools (i.e. the Meezan Academy, SET School and Green Island School) that already had screening and remedial setups in place for their students.

It is important to mention here that Karachi is a multilingual society and there are hardly any monolingual children because most are exposed to two or more languages from an early age given that Urdu is the 'lingua franca' for people from different provinces. All the provinces have their main regional language, a national language (Urdu) and an official language of correspondence, which is English. For most families the regional and national languages are the two main languages spoken at home. The regional language is mostly referred to as the heritage language, i.e. the language of the geographic region the child's family originally stems from. Urdu enjoys the status of "second first language." In Pakistani schools, Urdu and English are both regular compulsory subjects from grade 1 onwards. Although English is the official language of instruction in most private Pakistani schools, in the classroom the children communicate in Urdu and English, while during breaks and playtime they predominantly speak Urdu.

The children we wished to recruit had to have been exposed to Urdu and English in terms of listening, speaking, reading and writing from an early age, both at school and at home. Accordingly, the main inclusion criterion for our study was that children needed to speak and understand Urdu and that they had received at least two years of formal reading instruction in Urdu. The principals and teachers of the three selected schools were invited to attend orientation sessions about the study and required sample, after which they prepared lists of typical (TR) and struggling (SR) readers per class. The children's teachers were requested to compose an SR group based on academic performance (grades), classroom reading and spelling performance, including children showing reluctance to read. The final selection was performed through stratified random sampling until the target sample size was reached. The descriptives of the recruited sample can be found in Table 2.1.

A total of 295 children (150 boys and 145 girls), aged 7-11 years attending grades 3-7 were recruited, of whom 167 were characterized as typical readers by their teachers and parents and 128 as struggling readers[2]. Of these 128 struggling readers, a subset of 32 students had been diagnosed as having dyslexia in English based on the ASTON index (Newton and Thomson, 2003) prior to our study. However, no details of the diagnostic reports were shared. Both TR and SR group belonged to the same socio-economic status. Although sample size is often problematic in between-subject designs, we believe the present sample size generates sufficient statistical power to pursue the aims of this study (Faul et al., 2007).

[2] In this study, the term *struggling readers* refers to children experiencing reading and spelling problems and it is not known exactly how far they lag behind in comparison to their typically developing peers nor what causes the arrears. If not otherwise specified, the term dyslexia is used when the DSM-5 criteria for a specific learning disorder in reading and/or spelling are met (APA, 2013).

Table 2.1: Descriptives of the typical and struggling readers included in the study

Variables	TR group	SR group	Total
Number	167	128	295
Gender			
Female	83	62	145
Male	84	66	150
Total	167	128	295
Age (in years)			
7	25	24	49
8	17	40	57
9	43	26	69
10	34	19	53
11	48	19	67
Total	167	128	295
Grade/Class			
2	0	11	11
3	37	54	91
4	33	31	64
5	38	15	53
6	29	11	40
7	30	6	36
Total	167	128	295

Note: TR = typical readers; SR = struggling readers

2.2.2 Selection of the Test Items

We selected 300 words from grade 3-to-7 Urdu text books, excluding compound words (mostly derived from Persian), words with heavy Arabic influence and commonly mispronounced words. On the basis of these, we constructed the same number of corresponding pseudowords matched for the number of syllables. Next, frequency and age of acquisition of the words were rated by grade 3-to-7 teachers, after which 10 female and 10 male volunteers (18-80 years) with a minimum of 12 years of formal education performed a second independent rating on the same variables. Frequency was rated on a 3-point scale, with 1 denoting low and 3 denoting high frequency. The selected words were all typically acquired before the age of 7 years. On the basis of high correlations (frequency, Spearman $\varrho = 0.81$ and age of acquisition, Spearman $\varrho = 0.83$) between the two ratings, final test items were selected fulfilling the requirements of each test specified in the descriptions below.

2.2.3 Procedure

We ran a pilot test with 20 typical (TR; 10 boys) and 20 struggling readers (SR; 10 boys) whom we randomly selected from all relevant grades, while controlling for socio-

economic status. The pilot sample was representative of the total sample. Testing was on an individual basis and performed during school hours at the child's school. After the pilot, a small number of items was replaced with more contextually relevant and culturally fair items.

Actual testing was also conducted at the child's school in individual 45-60 minute sessions. Breaks were offered, if needed. All tests were paper and pencil tasks. Children could stop and leave the session at any time. Results were shared with the child's parents and teachers but not directly with the children themselves. Individual feedback and recommendations were provided after the session.

2.3 Theoretical Framework of Dyslexia Assessment Test

As mentioned above, we largely based the design of our Urdu reading assessment battery on the DRM for reading (Coltheart, 1978), which distinguishes various components and interconnected processes, depicted in Figure 2.1. Each component has specific functions and any deficits in these functions will manifest as different types of reading impairments (Coltheart, 1978; 2005; 2006), whose causes fall outside the focus of this paper (for a detailed aetiological account, see Reid, 2016). Each test taps into a corresponding DRM component (see Table 2.2 below). Following the DSM-5 definition of dyslexia, we also added a word and pseudoword spelling test, as well as other tests gauging cognitive skills known to be predictive of dyslexia, such as phonological awareness (PA) and rapid automatized naming (RAN). Since dyslexia is considered a multi-factorial condition, these cognitive skills are often associated with dyslexia but by themselves not sufficient or necessary for dyslexia to be diagnosed.

Table 2.2: The functions and reading impairments per DRM component

Components and pathways	Function/Deficits	Manifestations if defective	Reading Impairment
Orthographic-visual analysis	Letter identity Letter-position coding	Letter substitutions and omissions in isolation and in context (word) Transposition of letters	Letter-identification-dyslexia Letter-position-dyslexia
Processing routes	Whole-word recognition Letter-to-sound conversion	Problems in reading accuracy and speed of irregular words Problems in reading accuracy and speed of new words and pseudowords	Surface dyslexia Phonological dyslexia
Conceptual and semantic lexicon	Comprehension of words	Reading without knowing the meaning of words	Semantic dyslexia

2.4 Description of the Tests

All the tests in our battery are at the letter and word level as previous research has shown that tests at the sentence level contribute little to the identification of dyslexia (Tops, Callens, Bijn, & Brysbaert, 2013). By definition, dyslexia is about reading words; reading comprehension is functionally important but not a core characteristic of the deficit.

2.4.1 Letter Identification

This test corresponds to the first function of the DRM's orthographic-visual analysis component. It assesses letter-name and letter-sound knowledge, thus gauging a child's ability to name and sound-out Urdu letters. Deficiencies in both these skills distinguish struggling from typical readers in early reading development. Both are predictors of later word reading (de Jong & van der Leij, 1999; Lonigan, Burgess, Anthony, & Barker, 1998; Wimmer et al., 2000). As to letter naming, the child is shown a letter and asked to give the corresponding name (active naming), while in the letter-sound test, the administrator vocalizes the letter sound after which the child is to point out the matching letter (letter-sound matching). There are 20 items for each of the two skills (for sample items, see Figures 2.2 and 2.3) with accuracy being the only outcome measure (reading speed was not recorded).

LETTER NAME KNOWLEDGE STIMULI SHEET

ث	ے	ژ	ن	ج
د	ق	ا	ک	ل
ھ	ض	خ	غ	س
ء	ٹ	ز	ڑ	ط

Figure 2.2: Sample items from the letter-naming test

LETTER SOUND KNOWLEDGE STIMULI SHEET

و	ذ	گ	ر	ت
پ	چ	آ	م	ح
ش	ی	ڈ	ظ	ف
ں	ع	ص	ت	ب

Figure 2.3: Sample items from the letter-sounding test

Two of the selected letters, آ and ں , are variations of their original forms ا and ن , respectively. There was proper representation of consonants and vowels in both test sheets.

2.4.2 Letter-position Processing

Coinciding with the second function of the DRM's orthographic-visual analysis component, this test evaluates a child's ability to code the order of letters in words. Errors in letter position coding or letter migrations while reading are a hallmark symptom of letter position dyslexia (Kohnen et al., 2012). The test consists of 50 words presented on two separate lists, each including 25 words of a cognate pair. List 1 includes 25 high-frequency words and list 2, 25 low-frequency cognates. Each of the words in list 1 has a cognate in list 2 in which the letters has changed position, of which half are visually similar cognates (letters keeping the same shape) and half visually less similar cognates (letters changing shape). Children read aloud the 25 words of list one first, followed by those on list two. Outcome measures are accuracy and reading speed (for the two lists). Table 2.3 depicts some examples.

Table 2.3: Sample items from the letter position test

Words	**Roman**	**IPA**	**English Meaning**	**Same-Shape Cognate**	**Roman**	**IPA**	**English Meaning**
جواب	Jawaab	/j ə v aː b/	Answer	واجب	Waajib	/v aː j ɪ b /	Obligatory
ماتھا	Maatha	/m ɑː t̪ʰ ə /	Forehead	تھما	Thama	/ t̪ʰ ɑː m ə /	Hold
اور	Aur	/ ɔ r/	And	وار	Waar	/v aː r/	Attack
Words	**Roman**	**IPA**	**English Meaning**	**Change-Shape Cognate**	**Roman**	**IPA**	**English Meaning**
لات	Laat	/l aː t̪ /	Kick	تال	Taal	/ t̪ aː l/	Rhythm
سڑک	Sarak	/ s ə ɽ ə k /	Road	سکڑ	Sukar/d	/ s ʊ k ə ɽ /	Shrink
بادل	Badal	/b aː d ə l/	Cloud	بدلا	Badla	/b ə d l ə /	Revenge

2.4.3 Pseudoword Reading (Letter-Sound Correspondence)

Corresponding to the letter-to-sound conversion route of the DRM, this test gauges a child's ability to decode words based on his/her knowledge of the relationship between Urdu letters and sounds. If letter-to-sound conversion is impaired, errors will be made in reading new words and pseudowords, a reading difficulty known as phonological dyslexia (Castles and Coltheart, 1993; McDougall, Borowsky, MacKinnon & Hymel, 2005). The test consists of 30 pseudowords of increasing complexity that cannot be read by whole-word recognition. They are presented with diacritics (vowel markers) that enable the child to read it aloud correctly as long as s(he) knows the corresponding rules. Outcome measures are accuracy and reading speed. Examples are given in Table 2.4.

Table 2.4: Sample items from the pseudoword reading test

Words	Roman
ذِخ	Zikh
بَتُش	Batush
زِلچابُن	Zilchabun

2.4.4 Word Reading (Whole-Word Recognition)

Covering the visual-word-recognition pathway and orthographic-input lexicon component of the DRM, this test assesses a child's whole-word recognition skills. If this direct route is impaired, it will lead to errors in reading sight words or irregular words while the child may still be able to correctly articulate regular words and pseudowords, which would be indicative of surface dyslexia (Castles & Coltheart, 1993). The test comprises 30 existing words (without vowel diacritics) of increasing difficulty (i.e. one, two or three syllables) that can only be read through the direct route as the readers would not know the pronunciation unless they were familiar with them. Each word has one correct pronunciation only. Of the 10 words in each syllable category half are high- and half low-frequency words. Outcome measures are accuracy and reading speed. Examples are provided in Table 2.5.

Table 2.5: Sample items from the word reading test

Words	Roman	English meaning
پیار	piyar	love
مچھر	machchar	mosquito
کھلونے	khilonay	toys

2.4.5 Word Reading With and Without Diacritics

Consistent with the two routes of DRM, this test gauges the processing of words with and without full phonological information. It consists of two different lists each comprising the same 30 words either with diacritics commanding one pronunciation only or without diacritics where each word has two or three possible pronunciations. It differs from the pseudoword reading test in that in the present test real words are presented, while it differs from the word reading test in that the words included have not one but two or three possible pronunciations (and meanings). Outcome measures are accuracy and reading time. Examples are provided in Table 2.6 below.

Table 2.6: Sample items from the word reading test with and without diacritics

Words with diacritics	Roman	English meaning	Same words without diacritics	Roman	English meaning
سُونا	soona	deserted	سونا	sona/soona	gold/deserted
گُھٹنا	ghutna	knee	گھٹنا	ghatna/ghutna	decrease/knee
تُلا	tula	persistent	تلا	tala/tula	fry/persistent

2.4.6 Word and Pseudoword Spelling

In congruence with the DSM-5 definition of dyslexia, we also included a word and pseudoword spelling test to assess the children's ability to encode words (sound-to-letter conversion) based on their knowledge of the relationship between Urdu letters and sounds (pseudoword spelling), and whole-word memorization (word spelling). There is high co-morbidity and interdependency between reading and spelling impairments (Ehri & Snowling, 2004). Spelling by sound-letter conversion requires letters to be matched to corresponding speech sounds (Berninger et al., 1998; Ehri, 1998; Moats, 2004). Skilled spelling through whole-word memorization is supported by underlying knowledge of a word's print form, speech sounds and meaning (Ehri & Snowling, 2004). Once the spelling of a word has been mastered, its representation is committed to memory and easily accessed for fluent reading (Snow et al. 2005). Of the 30 items in this test, 15 are existing words arranged in the order of difficulty (five single syllable, five two and the remaining five three syllables). The other 15 items are matching pseudowords containing the same number of syllables. In this test the investigator says the word and child writes it down on a blank sheet of paper. The outcome measure is accuracy. Examples are shown in Table 2.7.

Table 2.7: Sample items from the spelling test of words and pseudowords

Words	Roman	English meaning	Pseudowords	Roman
درد	dard	Pain	لرد	lard
ملک	mulk	Country	چُلک	chulk
پہاڑ	pahaard	Mountain	فِگاڑ	figaard

2.4.7 Vocabulary

To measure functioning of the semantic lexicon and conceptual system components of the DRM, this test assesses a child's knowledge of the meaning(s) of words. The literature shows relationships between vocabulary deficits and at-risk readers (Pierce et al., 2007). Reading comprehension is the product of adequately decoding words and attaching the correct meaning to them (Snow, Burns & Griffin, 1998), with vocabulary size being directly connected to reading comprehension (Steven, 1999). A child may suffer from semantic dyslexia if they read words without attaching meaning to them (Pierangelo & Giuliani, 2006). Our vocabulary test has 62 items, each consisting of four pictures with each set being depicted on a separate page. One picture is the target picture and the others are: a phonological distracter (having the same initial phoneme as the target word), a semantic distracter (having a similar meaning to the target word) and an unrelated picture. The test administrator says the word aloud after which the child is expected to point to the correct picture. The outcome measure is accuracy. A sample item is provided in Figure 2.4.

Figure 2.4: Sample item from the vocabulary test

In Figure 2.4, the vegetable (lady finger or okra) in the upper right picture depicts the target word '**bh**indi', while the picture below it shows a 'gobhi' (cauliflower), a semantically related word. The upper left picture shows a '**bh**aalu' (a teddy bear), a phonetically related word, while the bottom left picture is of a 'kawwa' (crow), an unrelated word.

2.4.8 Phoneme and Syllable Deletion

Not having a corresponding DRM component, this test gauges phonological awareness (PA) and was included because PA has consistently been shown to be the single most crucial predictor of reading impairment (Park & Uno, 2015; Snowling, 1995; Snowling 2000; Torgesen, 1996; Wolf & Bowers, 1999). Phoneme blending and segmentation (addition and deletion) are typical tests to quantify PA in impaired readers (Lee, 2008). In our test, the investigator asks the child to leave out either the initial, middle or final phoneme or syllable of an orally presented word and then vocalize this truncated word. An example: the examiner orally presents the word تب ('/t ə b/' meaning 'then') and instructs the child to leave out the '/t/' sound (which is in initial position), after which the child is expected to say '/ə b/'. This is the only oral test in the battery. It consists of 30 items, 10 items each for initial, medial and final phoneme/syllable deletion, while in all three sets one-, two- and three-syllable words are equally represented. The outcome measure again is accuracy. See Table 2.8 for sample items.

Table 2.8: Sample items from the phoneme- and syllable-deletion test (phonological awareness)

Words	Roman	Meaning	Phoneme/ syllable deleted	Roman	Desired response	Roman
ماتم	matam	mourning	تم	tam	ما	ma
پانی	pani	water	پا	pa	نی	ni

2.4.9 Rapid Automatized Naming (RAN)

This test has no corresponding DRM component but was included because there is evidence of the predictive role of RAN in reading accuracy and fluency for Urdu (Farukh & Vulchanova, 2014). The test comprises four stimuli sheets showing colours, objects and digits (one for English, one for Urdu).The digits range from 1-9 and are presented in different order on the two sheets. The child needs to name the stimuli as accurately and as quickly as possible, with reading speed being the sole outcome measure.

Table 2.9 provides an overview of all the factors and corresponding tests and skills evaluated.

Table 2.9: Overview of the factors and corresponding tests

Factors	Tests	Measures
Letter Level		
Letter Knowledge	Active letter naming Recognition of letter sounds	Letter-name knowledge Letter-sound knowledge
	Phoneme deletion	Phonological awareness Phonological sequencing Phonological memory
Word Level		
Reading	Word Pairs (Letter Position)	Letter-position effect
	Pseudowords	Phonological decoding (letter-sound mapping)
	Words without Diacritics (1 reading possibility) (2 or 3 reading possibilities)	Visual-word recognition
	Words with Diacritics	Phonological Decoding Visual-word recognition
Spelling	Pseudowords Words	Phonological encoding (sound-to-letter mapping) Orthographic knowledge
Vocabulary	Vocabulary	Lexical retrieval Word-meaning knowledge
Rapid automatized naming (RAN)	Colours Objects Digits-English Digits-Urdu	Fast lexical retrieval

2.5 Results

2.5.1 Reliability

First, we calculated the reliability measures of the whole test battery (see Table 2.10). The overall test reliability was very high, Cronbach's $a = 0.94$; Guttman split-half $y = 0.97$, where we considered reliability coefficients to be high from .70 onwards (Fraenkel & Wallen, 2006).

Table 2.10: Descriptives and reliability coefficients per test

Tests	Total Items	Mean	Median	(SD)	Cronbach's α	Guttman split-half y
Letter-name knowledge	20	18.64	19	*(2.09)*	.82	.80
Letter-sound knowledge	20	18.94	20	*(2.29)*	.87	.80
Phoneme and syllable deletion	30	25.42	29	*(6.72)*	.95	.90
Reading letter position HF	25	20.57	23	*(6.11)*	.95	.94
Reading letter position LF	25	18.95	22	*(6.90)*	.95	.95
Reading pseudowords	30	20.12	26	*(10.32)*	.97	.94
Reading words	30	22.89	27	*(8.62)*	.97	.94
Reading without diacritics	30	23.87	28	*(8.42)*	.97	.96
Reading with diacritics	30	20.44	24	*(9.16)*	.96	.95
Spelling words	15	9.81	12	*(5.22)*	.94	.94
Spelling pseudowords	15	9.23	12	*(5.75)*	.96	.95
Vocabulary	62	61.47	62	*(1.09)*	.68	.47

Note: Reliability coefficients = Cronbach's α and the Guttman split-half y, HF = high-frequency, LF = low-frequency

Next, Cronbach's a and the Guttman split-half y of each test were determined separately based on the accuracy scores for all individual tests, except for RAN because it has speed as its sole outcome measure. For each test descriptives and reliability coefficients are given in Table 2.10. For all tests both reliability measures were higher than 0.80, except for Vocabulary where reliability was in the medium range, $a < .70$ and $y \leq 0.60$.

2.5.2 Validity

Content and construct validity, sensitivity and specificity were calculated for the overall test.

2.5.2.1 Content validity. Content validity was established during item selection (see method section above).

2.5.2.2 Construct validity. To judge the tests' construct validity, we calculated inter-test correlations for accuracy scores (Table 2.11), and speed measures (Table 2.12).

Table 2.11: Inter-test correlation matrix for accuracy

	LNK	LSK	RLPHF	RLPLF	RPW	RW	SW	SPW	V	PSD	RWND	RWD
LNK	1.00	.48	.59	.53	.43	.54	.46	.50	.28	.43	.53	.48
LSK		1.00	.59	.56	.44	.57	.49	.49	.29	.52	.57	.49
RLPHF			1.00	.90	.79	.89	.80	.74	.33	.60	.89	.83
RLPLF				1.00	.83	.90	.85	.78	.37	.60	.91	.87
RPW					1.00	.80	.79	.79	.37	.56	.80	.83
RW						1.00	.84	.76	.36	.62	.91	.88
SW							1.00	.89	.37	.62	.84	.83
SPW								1.00	.34	.64	.79	.75
V									1.00	.27	.30	.32
PSD										1.00	.67	.60
RWND											1.00	.90
RWD												1.00

Note: Spearman ρ was used for correlations. Interpretation: high correlation = .5 to 1.0 or -0.5 to -1.0; medium correlation = .3 to .5 or -0.3 to -0.5; low correlation: .1 to .3 or -0.1 to -0.3 (Cohen, 1988). All correlations were significant at the 0.01 level. Abbreviations: LNK=Letter Name Knowledge, LSK=Letter Sound Knowledge, RLPHF=Reading Letter Position High Frequency, RLPLF=Reading Letter Position Low Frequency, RPW=Reading Pseudowords, RW=Reading Words, SW=Spelling Words, SPW = Spellings Pseudowords, V=Vocabulary, PSD=Phoneme and Syllable Deletion, RWND=Reading without Diacritics, RWD=Reading with Diacritics

All the tests correlated positively. We computed significant ($a = .01$) and strong correlations between all reading and spelling tests. Similar high correlations were found in previous studies (Snow et al., 2005), indicating word reading, pseudoword reading and spelling to be interrelated and measuring similar domains. Correlations with vocabulary were moderate-to-low.

All speed measures correlated significantly ($a = .01$), with strong correlations for all reading tests. Correlations between reading and RAN were moderate, confirming previous findings where RAN was found to be a predictor for reading (Farukh & Vulchanova, 2014).

Taken together, the correlations of the accuracy and speed measures convincingly show the test battery to have high construct validity.

Table 2.12: Inter-test correlation matrix for speed measures (time in seconds)

	RLPHF	RLPLF	RPW	RW	RANC	RANO	RANDE	RANDU	RWND	RWD
RLPHF	1.00	.91	.62	.85	.51	.51	.59	.60	.83	.75
RLPLF		1.00	.66	.87	.53	.49	.53	.54	.84	.80
RSW			1.00	.70	.34	.31	.45	.40	.63	.66
RW				1.00	.51	.50	.54	.56	.85	.80
RANC					1.00	.60	.47	.58	.52	.42
RANO						1.00	.58	.62	.51	.43
RANDE							1.00	.66	.58	.50
RANDU								1.00	.56	.47
RWND									1.00	.87
RWD										1.00

Note: Spearman ρ was used for correlations. Interpretation: high correlation = .5 to 1.0 or -0.5 to 1.0; medium correlation = .3 to .5 or -0.3 to -0.5; low correlation: .1 to .3 or -0.1 to -0.3 (Cohen, 1988). RLPHF=Reading Letter Position High Frequency, RLPLF=Reading Letter Position Low Frequency, RPW=Reading Pseudowords, RW=Reading Words, RANC=Rapid Automatized Naming Colours, RANO=Rapid Automatized Naming Objects, RANDE=Rapid Automatized Naming Digits English, RANDU=Rapid Automatized Naming Digits Urdu, RWND=Reading without Diacritics, RWD=Reading with Diacritics

2.5.3 Group Comparisons

After having established the reliability and validity of our test battery, we ran group comparisons to see whether it would indeed distinguish between typical and struggling readers.

We compared both accuracy and speed scores for all the tests (except for RAN since speed was the sole measure) using Mann-Whitney U ($\alpha = .01$) and applying Bonferroni corrections because of the large number of tests. Group differences in accuracy and speed were expressed as effect sizes (ES; using Hedge's g to correct for any differences in sample size of the two groups), which are shown in Tables 2.13 and 2.14. We considered ES large when > 0.80, medium when between 0.50 and 0.80, and small when < 0.50. Positive values indicate a better performance for the typical readers as compared to their struggling peers.

As with the accuracy measures, large ES were found for all tests except for Letter-name knowledge and Vocabulary (both medium ES), with the SR group always performing poorer than the TR group. It should be noted that mean scores on the Vocabulary test were close to ceiling in both groups, indicating that this particular test was easy for all the children we tested.

Table 2.13: Accuracy scores for the typical (TR) and struggling readers (SR)

Tests	Total	TR (n=167)		SR (n=128)		Effect Size Hedges'
	Items	M	*(SD)*	M	*(SD)*	*g*
Letter-name knowledge	20	19.29	*(1.08)*	18.09	*(2.30)*	0.69*
Letter-sound knowledge	20	19.78	*(0.68)*	18.27	*(2.44)*	0.89*
Phoneme and syllable deletion	30	28.33	*(3.02)*	22.36	*(7.49)*	1.10*
Letter Position-high frequency	25	23.93	*(2.23)*	17.16	*(5.91)*	1.59*
Letter position-low frequency	25	23.15	*(2.38)*	14.36	*(6.63)*	1.86*
Pseudoword reading	30	27.41	*(3.06)*	11.55	*(8.75)*	2.55*
Word Reading (single pronunciation option)	30	28.02	*(2.95)*	17.27	*(8.53)*	1.77*
Words without diacritics (2-3 pronunciation options)	30	28.75	*(2.89)*	18.61	*(8.40)*	1.70*
Words with diacritics	30	26.21	*(4.04)*	13.87	*(8.35)*	1.96*
Spelling words	15	13.41	*(1.93)*	5.58	*(4.49)*	2.37*
Spelling pseudowords	15	13.24	*(2.41)*	4.28	*(4.34)*	2.64*
Vocabulary	62	61.77	*(0.55)*	61.16	*(1.27)*	0.65*

Note: All the differences are statistically significant ($P<0.01$)

Table 2.14: Speed measures (in seconds) for the typical (TR) and struggling readers (SR)

Tests	Total	TR (n=167)		SR (n=128)		Effect Size Hedges'
	Items	M	*(SD)*	M	*(SD)*	*g*
Letter position High Frequency	25	36.76	*(26.46)*	122.05	*(90.10)*	1.34*
Letter position Low Frequency	25	44.77	*(31.41)*	133.52	*(87.34)*	1.42*
Pseudoword reading	30	107.74	*(65.41)*	196.42	*(101.09)*	1.07*
Word reading (1 pronunciation option)	30	52.76	*(43.81)*	159.91	*(101.06)*	1.44*
Words without diacritics (2-3 pronunciation options)	30	44.03	*(30.28)*	123.77	*(76.01)*	1.45*
Words with diacritics	30	62.18	*(40.80)*	137.02	*(80.54)*	1.22*
RAN Colours	35	37.50	*(13.61)*	54.27	*(26.96)*	0.82*
RAN Objects	35	30.31	*(9.34)*	38.24	*(12.81)*	0.64*
RAN Digits English	35	17.80	*(9.45)*	30.57	*(28.41)*	0.72*
RAN Digits Urdu	35	26.11	*(16.36)*	41.70	*(24.14)*	0.77*

Note: All the differences are statistically significant ($P<0.01$), higher score = more time taken to read

All tests had large ES, except for RAN (medium ES for RAN-objects, and Urdu and English digits) in detriment of the SR group. We can summarize our main findings as follows:

- All the differences were significant ($\alpha = .01$), with poorer SR outcomes;

- Effect sizes for spelling measures were largest (g > 2), followed by reading measures;
- Effect sizes for reading accuracy (g > 1.50) were larger than those for reading speed (g < 1.50).
- Effect sizes (g > 2.5) for pseudoword reading and spelling were larger than those for word reading and spelling;
- RAN and Vocabulary both had medium ES, showing that tests outside the reading and spelling domain had clearly smaller ES, which could mean that they are less clinically relevant for the TR-SR distinction but exist as a separate construct independent of reading and spelling factors.

2.5.3.1 Sensitivity and specificity. We calculated sensitivity and specificity in different ways manipulating cut-off scores (Pc 16 or Pc 10) and population (whole group, children diagnosed with dyslexia in English or typical readers only). First, out of our sample of 295 children, 128 were characterized as struggling readers by their teachers and parents. With TR versus SR as the diagnostic categories, we plotted receiver operating characteristic (ROC) curves for word and pseudoword reading and, word and pseudoword spelling. The areas under the ROC curve were very high for all the tests (> 0.9). We also calculated the specificity and sensitivity of our tests based on the DSM-5 clinical diagnostic criterion that a child scoring less than the 16th percentile is to be considered having dyslexia (APA, 2013). The tests' specificity was very high (> 0.9) but their sensitivity low (< 0.6).

Second, since the 16th percentile threshold is based on the assumption of a normal distribution but our sample was not normally distributed, we plotted the reading (words and pseudowords; Figure 2.5) and spelling (words and pseudowords; Figure 2.6) scores of the TR and SR groups and recalculated the sensitivity and specificity based on the intersection points of the sample distribution (cut-off score 23 for reading and 12 for spelling – Figures 2.5 and 2.6). With these criteria both the specificity and sensitivity were very high (> 0.9).

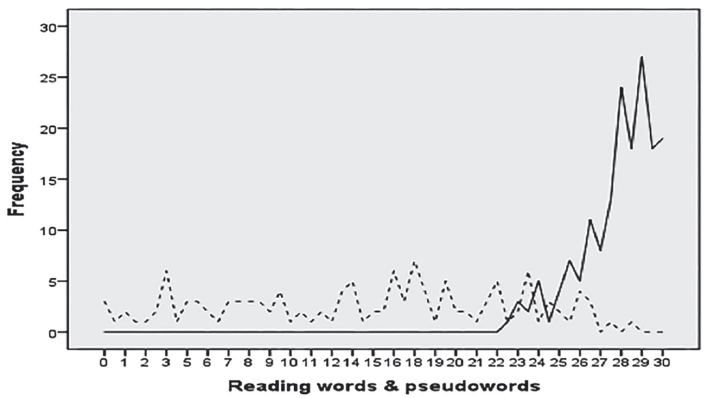

Figure 2.5: Distribution of typical and struggling readers on word and pseudoword reading where ____= typical and ------ = struggling readers

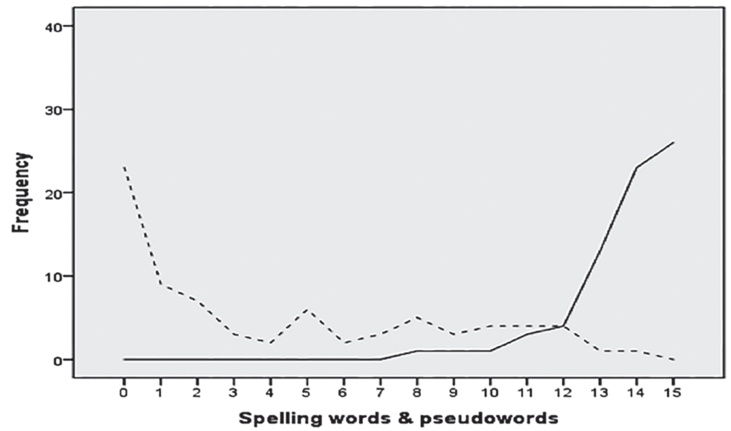

Figure 2.6: Distribution of typical and struggling readers on word and pseudoword spelling where ___ = typical and ------ = struggling readers

Third, we validated our results with another external criterion. As mentioned in the method section, of the 128 SRs, 32 had been diagnosed with dyslexia prior to our study based on the ASTON index for English. When we ran the sensitivity and specificity analysis on this diagnostic category, the area under the ROC curve (AUC), sensitivity and specificity were all very high (>0.9). All 32 children with dyslexia scored below the 16th percentile (DSM-5; APA, 2013).

Fourth, we conducted the different categorical analyses according to the *counting deficit method* (Pennington, 2012, p. 216) and determined 10% and 16% cut-off points based on the scores of typical readers only (excluding struggling readers). We calculated the new parameters with the value '0' if the score is above the 10th percentile and 16th percentile (condition is not present) and '1' if it is below (condition is present), for word reading, pseudoword reading, spelling of words and spelling of pseudowords. We then cross-tabulated the poor performers in the group of struggling and typical readers. Our results showed that only 3/167 typical readers fell in the lowest 10% in *reading words and pseudowords*, as compared to 97/128 of the struggling readers (98% specificity, 76% sensitivity), and 9/167 typical readers fell in the lowest 16% in reading words and pseudowords, compared to 108/128 of the struggling readers (95% specificity, 84% sensitivity). In case of *spelling words and pseudowords*, our results showed that 25/167 typical readers fell in the lowest 10% compared to 104/128 of the struggling readers (85% specificity, 81% sensitivity), and 42/167 typical readers fall in the lowest 16% in spelling words and pseudowords, compared to 114/128 of the struggling readers (75% specificity, 89% sensitivity). These outcomes are indicative of the robustness of our battery and further support that our test battery has high sensitivity and specificity based on the cut-off scores derived from the typical readers.

Finally, we took our analysis to a step further and explored the variability within the struggling reader group in order to observe whether our test provides the opportunity to assess specific patterns of reading and/or spelling deficits. We found that it does, as illustrated in the Tables 2.15 (16th percentile) and 2.16 (10th percentile).

Table 2.15: Profiling of struggling readers based on 16th percentile

Profiles	Deficit				No. of struggling readers
	Reading		Spelling		
	Words	Pseudowords	Words	Pseudowords	
Multiple deficit	√	√	√	√	96
Isolated reading deficit	√	√	x	x	2
Isolated spelling deficit	x	x	√	√	2
Word reading and spelling deficit	√	x	√	x	0
Pseudoword reading and spelling deficit	x	√	x	√	2
Multiple deficit except for word reading	x	√	√	√	8
Multiple deficit except for pseudoword reading	√	x	√	√	8
Multiple deficit except for word spelling	√	√	x	√	4
Multiple deficit except for pseudoword spelling	√	√	√	x	6
No deficit	x	x	x	x	0
Total struggling readers					128

Note: Profiles of struggling readers based on the 16th percentile criterion applied on the scores of typical readers, √ = presence of a deficit, x = absence of a deficit

When we interpreted both the profile tables, it was clear that the majority of struggling readers exhibited reading as well as spelling deficits, supporting the co-occurrence of these problems. However, we did observe specific patterns of deficits, such as some children had problems with reading only but not with spelling and vice versa. Moreover, there were few children with pseudoword reading and spelling issues but their word reading and spelling was not impaired, and there was only one child with the inverse condition. This indicates that phonological processing is probably more problematic for children struggling to read Urdu than the word recognition. We also found children who had problems with only one of the four skills while other three being unimpaired. Overall, our results support the argument that there are various profiles of dyslexia comprising of combinations of single and multiple deficits.

Table 2.16: Profiling of struggling readers based on 10th percentile

Profiles	Deficit				No. of struggling readers
	Reading		Spelling		
	Words	Pseudowords	Words	Pseudowords	
Multiple deficit	√	√	√	√	84
Isolated reading deficit	√	√	x	x	6
Isolated spelling deficit	x	x	√	√	7
Word reading and spelling deficit	√	x	√	x	1
Pseudoword reading and spelling deficit	x	√	x	√	4
Multiple deficit except for word reading	x	√	√	√	10
Multiple deficit except for pseudoword reading	√	x	√	√	3
Multiple deficit except for word spelling	√	√	x	√	1
Multiple deficit except for pseudoword spelling	√	√	√	x	6
Other combinations of deficit					6
No deficit	x	x	x	x	0
Total struggling readers					128

Note: Profiles of struggling readers based on the 10th percentile criterion applied on the scores of typical readers, √ = presence of a deficit, x = absence of a deficit

2.6 Discussion

The present study had three main objectives: (1) to develop and validate an assessment battery for young children to identify reading disability in Urdu, (2) to determine the reading and spelling profiles of typical readers (aged 7-11 years) and their struggling peers and (3) to test the applicability of the DRM to Urdu, which has a dual orthography. Our analyses of the data of 295 children showed the dyslexia battery to be reliable and valid as it clearly distinguished struggling from typical readers.

2.6.1 What Distinguishes Struggling from Typical Readers?

The scores on all tests were significantly lower for the struggling readers. Our study based on Urdu, representing the dual orthography, showed that the difference between typical readers and struggling readers was larger for reading pseudowords than for reading words. All children had more difficulties reading and spelling pseudowords than words. This *lexicality effect* was also reported in earlier studies (Landerl et al., 1997a; Rack, Snowling & Olson, 1992; Ziegler, Perry & Coltheart, 2003). Moreover, our finding is consistent with the literature on pseudoword reading deficits in consistent orthographies like German, where the effect manifests itself more in speed than in accuracy, and in less transparent languages, such as English, where accuracy is more impaired than speed (Landerl and Wimmer 2008; Ziegler et al., 2003). In DRM terms, this would suggest that, on average, our struggling readers showed a greater deficit in letter-to-sound conversion process than in direct word recognition.

Effect sizes of the group differences for letter-sound knowledge and, phoneme and syllable deletion were high, suggesting that poor phonological awareness (PA) plays an important role in the delay of reading acquisition in the struggling readers (Ehri & Snowling, 2004; Lyon et al., 2003; Ramus et al., 2003). Supporters of the phonological deficit hypothesis claim that dyslexia arises from a cognitive deficit in PA, making grapheme-to-phoneme conversions difficult, hampering reading acquisition (Bishop & Snowling, 2004; Lyon et al., 2003; Snowling, 2001; Vellutino et al., 2004; Ziegler & Goswami, 2005). Comparing our results for Urdu with those reported for Arabic, which also has a dual orthography and, like Urdu, is more (or less) consistent depending on the presence (or absence) of diacritics, we again see that PA is highly predictive of reading performance in typical and poor grade 1-5 readers (Abu-Rabia, Share, & Mansour, 2003; Al-Mannai & Everatt, 2005). Also in other languages PA is reported as one of the most important predictors for later literacy (Ehri, 2004; Pennington et al., 2012; Rath, 2001; Snowling & Melby-Lervag, 2016; Troia, 2004).

Effect sizes for spelling were the highest followed by those for the reading measures. Spelling and reading are highly connected and share the use of letter-sound conversions (Ehri, 2000). For reading, effect sizes were higher for accuracy than for speed, which is congruent with previous studies (e.g., Callens, Tops, & Brysbaert, 2012). High correlations (Tables 2.11 and 2.12) between reading and spelling tests confirm that reading and spelling impairments often co-occur (Katzir et al., 2006), as is also mentioned in many definitions of dyslexia (e.g. DSM-5; APA, 2013).

Finally, RAN and vocabulary had the lowest effect sizes of all tests, although they still were medium to high, signifying that the two factors do explain reading variability to some extent, which is consistent with previous findings (Furnes & Samuelsson, 2011; Kail, Hall, & Caskey, 1999; Kirby, Parrila, & Pfeiffer, 2003). The RAN-digit subtest (Urdu ES = 0.77, English ES = 0.72) was a stronger predictor of reading than the RAN-object subtest (ES = 0.64), again consistent with the literature (Neuhaus, Foorman, Francis, & Carlson, 2001).

The specific role of vocabulary in reading and spelling acquisition is still under debate and the current evidence is mixed. It was suggested that its contribution to reading and spelling varies across age groups and/or reading stages, where it seems a strong predictor in early reading acquisition but becomes less predictive with increasing proficiency (Vaessen & Blomert, 2010). Arguably, the medium effect sizes for vocabulary may be explained by the fact that our participants had received at least two years of formal reading instruction before participating in this study. Highly likely they acquired a substantial level of vocabulary that is reflected in the close-to-ceiling scores of both groups.

2.6.2 Assessing Dyslexia in Urdu

Our test battery was found to have high reliability and validity, and it also discriminated well between typical and struggling readers as a group. We ran multiple analyses based on different criteria, showing that the battery's sensitivity and specificity are overall very high (> 0.9). Using the internationally recognized 16th percentile criterion (DSM-5), we found that all the children with a confirmed diagnosis of dyslexia in English were screened out, demonstrating that this external criterion is applicable to our assessment battery and supports its clinical relevance. Still, when we considered all the 128 struggling readers using the 16th percentile cut-off score, the specificity rate remained very high (0.9) but the sensitivity rate dropped substantially (< 0.6), implying that not all the struggling readers were screened out. There can be two possible reasons for that. First, the SR group probably did not only consist of children with dyslexia but included in the SR group might be readers struggling due to delayed reading and/or delayed language development, having psychological problems and/or less favourable backgrounds (e.g. low parental socioeconomic status). Second, our findings point towards the heterogeneity of dyslexia. Reading and spelling impairments are manifested so differently that every child with dyslexia possesses a unique combination of symptoms. The large variance that is exhibited in our data of struggling readers could be explained by this heterogeneous nature of dyslexia.

In addition to group average comparisons, we explored the variability within the struggling reader group because our test allowed the assessment for specific patterns of reading and spelling deficits. Our results showed evidence for different profiles in dyslexia such as isolated reading and/or spelling deficits, and isolated problems in reading and spelling words and/or pseudowords. More importantly, our findings support the claim that the DRM is applicable to Urdu, not only as a model for typical reading but also for impaired reading. Moreover, children showing isolated pseudoword deficits were twice as many as children showing isolated word deficits in our sample. Hence, this indicates that phonological deficits may be more common than orthographic deficits in Urdu struggling readers.

2.6.3 Education and Literacy Instruction in Pakistan

In a developing country like Pakistan, the school situation differs from that in developed countries. Parents, teachers and school management often lack an awareness and understanding of the learning process and behavioural problems. The poor quality of teaching and learning, un(der)trained teachers and outdated curricula compromise an adequate identification of children with specific learning disabilities like dyslexia and those that 'merely' lag behind in reading and writing. Clearly, the general public needs to be better informed, while parents, teachers and school-management staff need to be educated and trained in the recognition, assessment and remediation of literacy problems and dyslexia (Khan et al., 2011).

Other complicating factors are the scarcity in resources and lack of specialized, approved services that could perform targeted assessments, while existing remedial services 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.

Acknowledgements

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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).

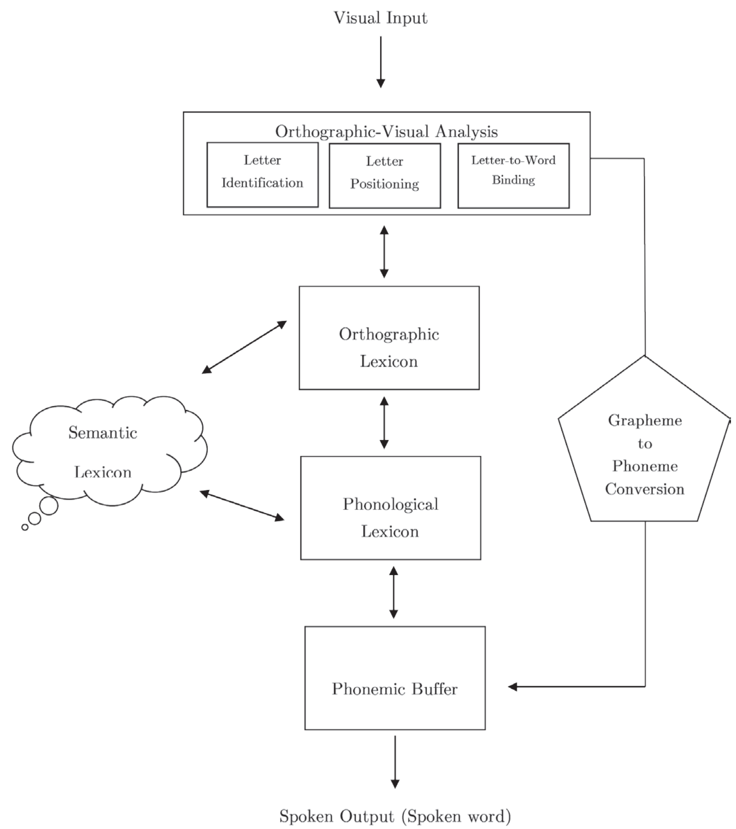

Figure 3.1: The components of the dual-route model of reading aloud (DRC Model - Coltheart, Rastle, Perry, Langdon and Ziegler, 2001. Figure 6, page 213)

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** **High or low**	**Length** **1 or 2 syllables**	**TR** M(%)	***(SD)***	**SR** 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

Condition	**TR n=167** **M**	***(SD)***	**SR n=128** **M**	***(SD)***	**Difference in Means**
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 from their significantly poorer and slower performance on reading/decoding tasks comprising words with diacritics and pseudowords compared to typical readers. Although the struggling readers in our study were not formally diagnosed with dyslexia, our results do add to an existing body of evidence favouring the phonological deficit being at the core of reading-related issues (Snowling, 2000). We accordingly suggest that formal Urdu reading instruction should include the teaching of adequate strategies that enable children to build letter-to-sound associations from an early age, which is currently not a common practice in Pakistan.

Acknowledgement

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CHAPTER 4

Letter-Position Effects in Typical and Struggling Readers of Urdu

Abstract

Background: Urdu has approximately 100 million native speakers in Pakistan. Its orthography is cursive in nature and letters change shape depending on their position in a word. But how are letters processed in Urdu by the orthographic visual-analysis component of the reading system that is responsible for the determination of the position of letters? And does a change in shape cause difficulties in ordering letters within words, the so-called letter-position effect?

Aims: The shape, frequency and position of letters within Urdu words were manipulated, while the effects of these manipulations on letter processing in typical and struggling readers are compared.

Method: Based on their teachers' and parents' judgments, 295 7-to-11-year-olds (150 boys) recruited from schools in Karachi, Pakistan, were assigned to a typical-readers (n=167) or a struggling-readers group (n=128) and asked to read two lists of 25 words each in which letters varied in shape, frequency and position.

Results: Compared to same-shape migrated-letter cognates, reading accuracy was superior for migrated-letter cognates that changed shape due to their new position, as well as for high-frequency words (having low-frequency cognates) compared to low-frequency words (having high-frequency cognates). All children were also better at reading word pairs containing letters that changed initial and final positions compared to word pairs where letters changed medial positions. Reading accuracy in the struggling readers was, however, always significantly poorer to that of the typical readers.

Conclusion: Position-dependent letter forms facilitate letter-position processing in both typical and struggling readers of Urdu.

Keywords: letter-position effects, migration errors, frequency effect, Urdu, typical and struggling readers

4.1 Introduction

Teachers commonly report that some children read 'two' as 'tow' and 'who' as 'how' or vice versa. This is the so-called letter-position effect where children swap the initial, medial and/or final position of letters in a word while reading. Children who consistently show these errors have been described as having a specific form of dyslexia known as developmental letter-position dyslexia (LPD) (Friedmann & Rahamim, 2007). Letter-position swapping or migration errors have been reported for a number of different orthographies, including English (Kohnen & Castles, 2013; Kohnen, Nickels, Castles, Friedmann & McArthur, 2012), Hebrew (Friedmann & Rahamim, 2007) and Arabic (Friedmann & Haddad-Hanna, 2012). In the present study, we are the first to explore letter-position processing in the Urdu orthography.

We based our study on the dual-route model (DRM) of reading (Coltheart et al., 2001; Ellis & Young, 1988), which proposes that the first component in the reading process is orthographic-visual analysis (see Figure 4.1), which has three separate functions: (1) identification of letters, (2) encoding of letter positions within a word, and (3) letter-to-word binding (allocation of letters to the word they belong to). There is evidence to suggest that these three functions can be selectively impaired, leading to three distinct types of reading errors, i.e. identification errors (e.g. form as farm or fork), migration errors (e.g. form as from) and letter-to-word binding errors (e.g. dark part as park dart) (Kohnen et al., 2012).

The orthographic lexicon and the phonemic buffer, two other components of the DRM, could, theoretically, also be responsible for migration errors. However, Friedmann and Rahamim (2007) argue that the orthographic-visual analysis stage is the most likely cause as in their study Hebrew-speaking participants diagnosed with developmental LPD made many more letter-migration errors (e.g. smile-slime) than identification errors, leading to orthographically similar words (e.g. blows-brows), which would not be predicted by a deficit in the orthographic lexicon. Also, the participants were not impaired on a word and non-word repetition task and a task gauging phonemic awareness. These findings are incongruent with a deficient phonemic buffer. In their study with three English-speaking children with LPD, Kezilas et al. (2014) also ruled out the role of the phonemic buffer and the orthographic lexicon. Like Friedmann and Rahamim, they strongly argue that the orthographic-visual analyser is most likely responsible for, or at least plays a key role in, letter-migration errors.

Our study also focuses on the factors influencing the second function of the orthographic-visual analyser but now in beginning readers of Urdu. We were curious to know whether and, if so, why typical and struggling readers of Urdu make frequent letter-migration errors when assigning positions to letters within words. Studies on Hebrew, Arabic (Friedmann, Dotan & Rahamim, 2010; Friedmann & Gvion, 2001, 2005; Friedmann & Haddad-Hanna, 2012; Friedmann & Rahamim, 2007), and English (Kohnen & Castles, 2013) have shown that migration errors mostly occur when the output produces another similar-looking word (e.g. form being read as from). These studies also reported that most migration errors occur due to medial migrations (e.g., spot–stop versus male-lame;

Friedmann & Rahamim, 2007; Khentov-Kraus & Friedmann, 2011). Moreover, migration errors were shown to be more common for adjacent (e.g., form-from) than for non-adjacent (e.g. smile–slime) letters (Friedmann & Gvion, 2001; Friedmann & Rahamim, 2007).

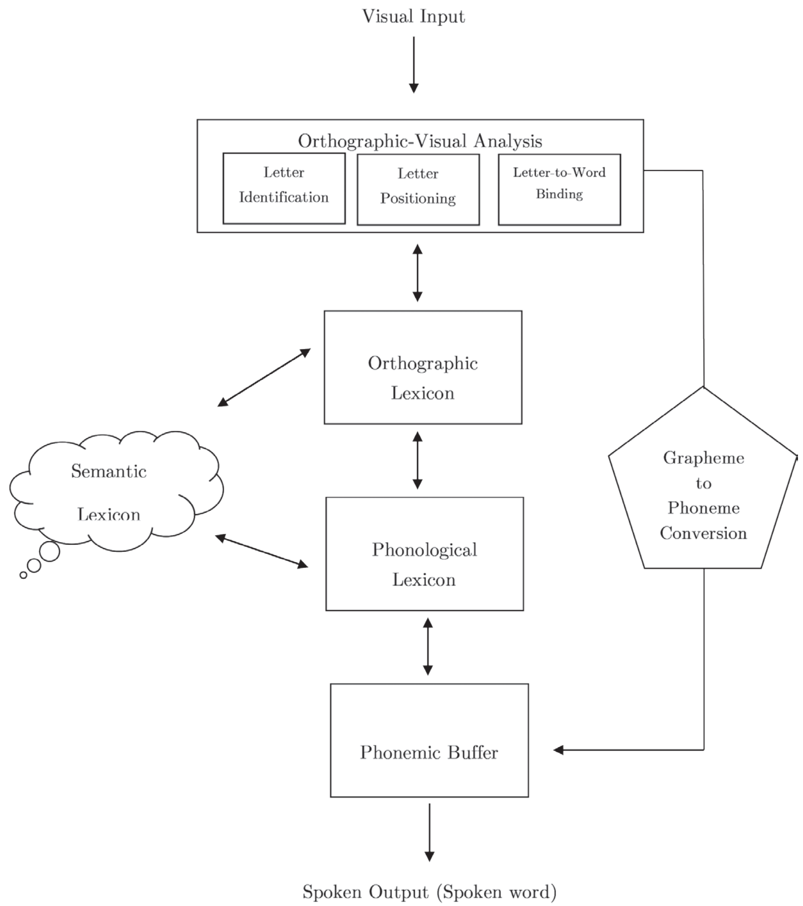

Figure 4.1: The components of the dual-route model of reading aloud (DRC Model - Coltheart, Rastle, Perry, Langdon and Ziegler, 2001. Figure 6, page 213; Friedmann & Rahamim, 2007; Kezilas et al., 2014; Kohnen et al., 2012)

Friedman and Haddad-Hanna (2012) studied developmental LPD in Arabic, which is an interesting orthography in this respect as letters take a different form depending on their position in the word. Comparing migrations errors made when letters did not change shape and when letters did, the authors found that changes in letter shapes had a significant effect on error rates. The children with LPD made fewer errors when letters changed shape than when their shapes remained the same.

Earlier, Friedmann and Rahamim (2007) argued that letter-position errors occur due to an *imprecise specification* rather than to the *incorrect coding* of medial letters in a word. When reading ‘slime’ as ‘smile’, the position of the ‘l’ could be anywhere between positions two and four rather than that the ‘l’ is coded in fourth position instead of the second. The authors supported their claim with evidence of a frequency effect. Reasoning that if it were just a matter of incorrect coding, the incorrect word activated in the lexicon as a result of incorrect coding would be produced regardless of word frequency, the authors found more migration errors when low-frequency words were being read (e.g. slime) than when their high-frequency cognates (e.g. smile) were being read. This appears to suggest that, due to imprecise specification, a number of alternative words are activated in the lexicon, where the most frequent word is then more likely to be selected.

Factors affecting letter position processing have never been studied for Urdu, which is an Indo-European language spoken in Pakistan and various parts of India, as well as in the South Asian diaspora (Middle East, UK, USA, Canada, etc.). Having around 588 million speakers, Urdu-Hindi is the second most widely spoken language in the world after Chinese (Rahman, 2004; Ulrich, 2015). Its alphabetic system has around 40 single letters, is cursive in nature and written from right to left. Its orthography is derived from Persian (which itself was derived from Arabic). While sharing similarities and differences with other languages like Persian and Arabic, Urdu has unique linguistic properties that make it highly suitable to study the letter-position effect. Similar to Arabic, its orthography consists of multiple letter forms where each letter changes shape according to its position in a word. For example, the shapes of the letter ‘غ /ɣ/’ in Urdu change from ‘غ’ in isolation, غـ in initial, ـغـ in medial and to ـغ in final position. Urdu might hence seem more difficult to read compared to English, for instance. Arguably though, different letter forms may facilitate letter-position processing and even possibly reduce specific reading impairments such as LPD (Friedmann & Haddad-Hanna, 2012). Indeed, if letters do not change shape when swapped, they form a visually very similar word. But if letters do change shape when swapped, words take on visually very different forms. We accordingly hypothesised that the higher the similarities in visual word form between a word and its cognate with a different letter sequence, the greater the chance of migration errors. Urdu is an interesting orthography to test our hypothesis, as it allows two shape-related letter migrations. The first is when swapping ‘*same-shape’* letters results in an orthographically similar and legitimate output (i.e. an existing correctly spelled word) as is shown in Table 4.1.

Table 4.1: Letters retaining their shape after swapping (visually similar cognates)

Words	Roman	IPA	English meaning	Same-shape cognates	Roman	IPA	English meaning
جواب	Jawaab	/j ə v aː b/	Answer	واجب	Waajib	/v aː j ɪ b /	Obligatory
ماتها	Maatha	/m ɑː t̪ʰ ə /	Forehead	تهاما	Thaama	/ t̪ʰ ɑː m ə /	Hold
اور	Aur	/ ɔ r/	And	وار	Waar	/v aː r/	Attack

Note: IPA=International Phonetic Alphabet

The second is when swapping '*changed-shape'* letters result in words that are visually different from the target word (see Table 4.2). Here, if the original shapes of the letters are retained, this will result in an illegitimate string of letters.

Table 4.2: Letters changing shape after swapping (visually dissimilar cognates)

Words	Roman	IPA	English meaning	Changed-shape cognates	Roman	IPA	English meaning
لات	Laat	/l aː t̪ /	Kick	تال	Taal	/ t̪ aː l/	Rhythm
سڑک	Sarak	/ s ə ɽ ə k /	Road	سکڑ	Sukar/d	/ s ʊ k ə ɽ /	Shrink
بادل	Baadal	/b aː d ə l/	Cloud	بدلا	Badla	/b ə d l ə /	Revenge

Note: IPA=International Phonetic Alphabet

We manipulated three factors likely to be implicated in the letter-position effect in Urdu. First, we compared reading accuracy of words where letter migration involves letters changing shape, with words where letter shapes remain unchanged. Second, we compared the reading speed for high-frequency words (having low-frequency cognates), with low-frequency words (having high-frequency cognates). Third, we contrasted cognates where the initial and final letters migrated with cognates where medial letters changed position.

Letter-position errors are found in children with LPD (Arabic and Hebrew; Friedmann & Haddad-Hanna, 2012; Friedmann & Rahamim, 2007) as well as in typical readers (English; Kohnen & Castle , 2013), suggesting that imprecise letter-position processing is not specific to impaired reading. We therefore compared the reading performance of typical and struggling readers of Urdu in a large sample of 7-to-11-year olds.

4.2 Method

This research was approved by the Macquarie University Human Research Ethics Committee (Australia, Reference No. 5201300826) and by the Research Ethics Committee (CETO) of the Faculty of Arts of the University of Groningen (The Netherlands).

4.2.1 Participants

The same 295 children (150 boys), aged 7-to-11 years, attending grades three to seven of three private middle-income schools in Karachi (Pakistan) reported on in our earlier chapters (two and three) participated in the current study. The students were subdivided into typical readers (TR=167) and struggling readers (SR=128). Since with our successive study we were in the process of developing and testing a dyslexia test for Urdu, for this study struggling readers were identified by their teachers and parents based on the children's reading and spelling performance. All children had received at least two years of formal reading instruction in Urdu and spoke Urdu as one of their primary languages both at school and in the home.

4.2.2 Materials

At the start of our research, 300 words were selected from grade 3-7 school Urdu textbooks, excluding compound words (mostly derived from Persian), words with heavy Arabic influence and commonly mispronounced words. The frequency of the words was rated by the participating teachers on a 3-point scale (1 denoting a low and 3 a high frequency) and by a group of 10 female and 10 male volunteers (18-80 years) with a minimum of 12 years education. The correlation between the two ratings was high (Spearman $\varrho = 0.81$). We subsequently selected 50 words from this pool and divided these into two lists of 25 words each, with list 1 including 25 high-frequency words (rated 3) and list 2, 25 low-frequency cognates (rated 1). Each of the words in list 1 had a cognate in list 2 in which the letters had changed position, of which half were visually similar cognates (letters kept the same shape) and half visually less similar cognates (letters had changed shape). Examples are given in Tables 4.1 and 4.2. Finally, of these 50 words, 10 (5 pairs) had initial-final letter migrations and 10 medial-letter migrations, which we analysed separately.

4.2.3 Procedure

The children read out the two word lists alternately in randomised order during a single individual session. They were instructed to read and verbalise the words as accurately and as fast as possible. Both reading accuracy (the number of correctly read words) and reading speed (the number of seconds used to read a full list of 25 words) were recorded for both lists.

4.2.4 Statistical Analyses

We performed three separate analyses. We first analysed the *accuracy* data for the factors shape, frequency and reading status (TR versus SR) using repeated measures ANOVA. Second, since *reading speed* data were only available for word frequency, we analysed it separately. Third, as the accuracy data for the factor *letter position* concerned 10 word pairs (and not 25 word pairs), we conducted a separate analysis on this dataset.

The ANOVAs conducted with and without outliers elicited the same results, therefore 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 are mentioned as partial eta squared (η_π^2; small= .01, medium = .06, large = .14).

The reading-speed data for frequency and the accuracy data for letter position had unequal variances and were not normally distributed. Therefore, between-group differences were tested with Mann-Whitney U tests and within-group comparisons with Friedman tests. Results were expressed as effect sizes (ES) using Hedges' g (small = .2, medium = .5, large = .8, very large = 1.3).

4.3 Results

4.3.1 Shape, Frequency and Reading-Status Results

The accuracy results for the factors shape, frequency and reading status are summarised in Table 4.3.

Table 4.3: Accuracy results for letter shape and frequency for the two study groups

		TR n=167		SR n=128	
Shape Condition	**Frequency**	**M (%)**	***(SD)***	**M (%)**	***(SD)***
Changed-shape	High	94.70	*(15.63)*	69.11	*(26.22)*
	Low	93.60	*(15.65)*	60.82	*(29.17)*
Same-shape	High	93.66	*(15.90)*	64.84	*(25.57)*
	Low	88.42	*(16.71)*	49.87	*(27.92)*

Note: p < .001, accuracy = proportion of correctly read words, TR = typical readers, SR = struggling readers

We conducted repeated measures ANOVA to determine the effects of shape (changed/same), frequency (high/low) and reading status (typical readers/struggling readers) on reading accuracy measures (see Table 4.3). We found main effects of shape, frequency and reading status. Changed-shape cognates were read better than same-shape cognates, [Shape, F (1, 293) = 100.47, $p < .001$, $\eta_\pi^2 = .25$]. High frequency words (with low frequency cognate) were read better than low frequency words (with high frequency cognates), F (1, 293) = 148.17, $p < .001$, $\eta_\pi^2 = .34$. Typical readers performed better than struggling readers in all the conditions, F (1,293) = 177.01, $p < .001$, $\eta_\pi^2 = .38$. Moreover, we found significant interactions. Frequency had larger effect in struggling readers than in typical readers, [Frequency x Reading status, F (1, 293) = 48.39, $p < .001$, $\eta_\pi^2 = .14$]. Frequency had less effect in changed-shape than in same-shape cognates [Frequency x Shape, F (1, 293) = 35.86, $p < .001$, $\eta_\pi^2 = .11$]. Shape had a larger effect in struggling readers than in typical readers [Shape x Reading status F (1, 293) = 17.72, $p < .001$, $\eta_\pi^2 = .06$]. All the effect sizes were large except for interactions between shape and frequency, and between shape and reading status.

4.3.2 Reading Speed for High- and Low-Frequency Words

Reading-speed results for the factor frequency are summarised in Table 4.4.

Table 4.4: Reading speed (in seconds) for high- and low-frequency words for the two study groups

	TR n=167		SR n=128		Mean difference
Condition	**M**	***(SD)***	**M**	***(SD)***	**(seconds)**
High-frequency words	36.76	*(26.46)*	122.05	*(90.10)*	85.29
Low-frequency words	44.77	*(31.41)*	133.13	*(85.92)*	88.36

Note: *p < .001; reading speed for the two 25-word lists is in seconds, a higher mean indicating longer reading times; TR = typical readers, SR = struggling readers

The non-parametric between-group analyses generated a significant difference for high- and low-frequency words, with the large effect sizes (ES > 1) demonstrating that the struggling readers needed significantly more time to read the lists than their typically reading peers. This was true for the high-frequency words, $U = 1904$, $z = 11.47$, $p = .001$, $g = 1.30$, and the low-frequency words, $U = 1899$, $z = 11.40$, $p = .001$, $g = 1.40$. The non-parametric within-group comparisons showed that both groups read the list of high-frequency words faster than they did the list of low-frequency words, with the difference being significant for both groups: TR, $\chi2$ (1) = 48.21, $p < .00$, $g = .27$; SR, $\chi2$ (1) = 34.71 $p < .001$, g = .12. However, effect sizes for both groups were small (ES < .3). We also found a significant interaction between reading speed and reading status as difference between the reading speed of high and low frequency words was significantly larger for struggling readers than for typical readers, TR *Mean difference* = 8.01, $SD = 19.39$; SR *Mean difference* = 11.09, $SD = 47.69$; $U = 8864$, $z = 2.51$, $p = .012$, $g = .08$. The effect size was small, $g = .08$.

4.3.3 Outcomes for Medial and Initial-Final Letter Migrations

Accuracy results for the factor letter position are summarised in Table 4.5.

Table 4.5: Reading accuracy for words with medial or initial-final letter migrations for the two study groups

	TR n=167		SR n=128		
Condition	**M(%)**	***(SD)***	**M(%)**	***(SD)***	**Mean difference**
Medial-letter migrations	86.59	*(17.72)*	48.12	*(25.18)*	38.47
Initial-final letter migrations	97.12	*(15.45)*	77.73	*(27.58)*	19.39

Note. * $p < 0.01$, accuracy is percentage of correctly read words, total number of words is 10 for each category of letter-migrations, TR = typical readers, SR = struggling readers

The between-group non-parametric comparisons for reading accuracy produced significant differences for both types of word pairs (medial and initial-final letter migrations). Effect sizes were large (ES > 0.8), signifying that the SR group had made significantly more errors than the TR group in reading word pairs with medial migrations, $U = 2207$, $z = 11.82$, $p = .001$, $g = 1.80$, and word pairs with initial-final migrations, $U = 4834$, $z = 9.93$, $p = .001$, $g = 0.90$. The non-parametric within-group comparisons showed that initial-final letter migrations were read better than medial letter migrations. The differences between conditions were significant for both groups: TR, $\chi2$ (1) = 93.12, p < .001, $g = .63$; SR, $\chi2$ (1) = 89.69 $p < .001$, $g = 1.11$, with medium ES for the TR group, $g = .63$ but large ES for the SR group, $g = 1.11$. We also found a significant interaction between migration position and reading status as the difference between the accuracy of medial and initial-final migrations was significantly larger for struggling readers than for typical readers, TR *Mean difference* = 10.54, $SD = 11.52$, SR *Mean difference* = 29.61, $SD = 22.14$, $U = 16551.50$, $z = 8.22$, $p = .001$, $g = 1.12$. Effect size for interaction was large, $g = 1.12$.

In summary, as to reading accuracy, all the children performed significantly better in reading changed-shape cognates compared to same-shape cognates (large ES: $\eta_\pi^2 = .60$), as well as reading high-frequency words (having low-frequency cognates) compared to low-frequency words (having high-frequency cognates) (large ES: $\eta_\pi^2 = .33$). Overall, typical readers performed better than struggling readers, again showing a large ES ($\eta_\pi^2 = .37$). Within-group differences for high- and low-frequency cognates were larger for the struggling readers than for typical readers, with a large ES ($\eta_\pi^2 = .14$). Frequency also affected the reading of same-shape cognates more than the changed-shape cognates, with a close-to-large ES ($\eta_\pi^2 = .09$). Struggling readers showed greater difference between changed- and same-shaped cognates compared to typical readers exhibiting medium effect size ($\eta_\pi^2 = .06$).

Results also showed that initial-final letter migrations were read better than medial letter migrations, with a medium ES for typical readers ($g = .63$) and a large ES for struggling readers ($g = 1.11$). Moreover, struggling readers made significantly more errors than typical readers when reading word pairs with medial as well as initial-final letter migrations, both with large ES ($g > .8$). The ES for significant interaction between migrated-letter position and reading status was large ($g = 1.12$).

High-frequency cognates were read faster than low-frequency cognates by both groups but with small ES ($< .3$). The struggling readers needed significantly more time to read both high- and low-frequency cognates than the typical readers, which was demonstrated by large ES (> 1). The ES for significant interaction between reading speed and reading status was low ($g = .08$).

4.4 Discussion

As Urdu letters may change shape according to their position in a word, we explored letter-position effects in 7-to-11-year-old typical and struggling readers of Urdu. We compared the influence of word frequency and various letter positions (initial, medial, final), two factors assumed to play a role in letter-position errors. Below, we will discuss our findings for each of these factors.

4.4.1 Letter shape

We found a main effect of shape with a very large effect size ($\eta_\pi^2 = .60$): reading accuracy was significantly higher for words in which letters changed shape than it was for cognates where the letters kept the same shape. This implies that a change in the shape of letters across the various positions in words facilitates word recognition and hence reading. One might expect that letters with multiple position-dependent letter forms complicate the reading process, but our results showed that the opposite is true for Urdu, which is consistent with previous findings in Arabic-speaking individuals with LPD (Friedmann & Haddad-Hanna, 2012). In Arabic, all the letters may change form contingent upon their position within a word and the authors found that their participants made almost no letter-position errors when this was the case. By comparison, in Hebrew only

five letters change form, and one bilingual participant made more errors reading Hebrew than was the case for Arabic. In same-shape migrations error rates were similar for the two languages. Friedmann and Haddad-Hanna accordingly postulated that the reading advantage of position-dependent letter-form changes is due to the fact that erroneous migrations in cognates where a form change is required would result in orthographically illegitimate words. Although our struggling readers read significantly less accurately than their unimpaired peers, the effects for letter migrations with form changes and those without form changes were comparable for both groups.

4.4.2 Word Frequency

Both the typical and the struggling readers were more accurate and faster in reading high-frequency words with a low-frequent cognate than vice versa. Thus, if by letter migration a low-frequency word becomes a high-frequency cognate, this increases the risk of migration errors significantly more than it does in the inverse condition. Our results are consistent with the findings of studies assessing Hebrew-speaking children with developmental LPD (Friedman & Nachman-Katz, 2007; Friedmann & Rahamim, 2007) and acquired LPD (Friedmann & Gvion, 2001). In these studies migration errors were also higher for less frequent words than for their more frequent counterparts, with the direction of errors being the same as we observed (from the less frequent to the more frequent cognate).

On a theoretical note, our findings support Friedmann and Rahamim's (2007) suggestion that it is an under-specification of letter positions rather than incorrect coding in the orthographic-visual analyser that lies at the heart of letter-position errors. Arguably, if the input from the orthographic-visual analyser to the lexicon is underspecified, then more than one word will be activated in the lexicon – the correct word and its migration neighbour. As the reader does not know which word is the correct one, s(he) is more likely to select the high-frequency word due to its higher baseline activation level. If the input was simply coded incorrectly, the reader would always choose the wrong word, regardless of its frequency.

Friedmann and Rahamim (2007) further argued that information about letter positions is particularly underspecified with respect to the position of medial letters, which contention we tested and will discuss in more detail in the next section.

4.4.3 Letter-Position

Comparing typical and struggling readers reading words with medial-letter and initial-final letter migrations, we found that reading accuracy was indeed more affected in the medial-letter migrations in both groups but more so in the struggling readers, which is consistent with the previous research on medial letters' higher susceptibility to migrations, both in unimpaired (Pitchford, Ledgeway & Masterson, 2008; Schoonbaert & Grainger, 2004) and impaired readers with LPD (Friedmann & Gvion, 2001; Friedmann & Haddad-Hanna, 2012; Friedmann & Rahamim, 2007).

The previous and our results could be explained with Kohnen and colleagues' (2012) argument that initial and final letters may have a perceptual advantage over medial letters because they are adjacent to one letter only (at one side they have an empty space), thus having fewer closely neighbouring letters to interfere with their processing compared to medial letters. This interference in the perception of letters due to the presence and/or proximity of adjacent letters is known as the crowding effect (Bouma, 1970). Evidence of the facilitating effects of wider letter spacing largely comes from studies on inter-letter spacing; compared to conventional letter spacing, a little increase in the space between letters within a word reduces the negative effects of crowding. It has also been suggested that more appropriately spaced letters could also facilitate letter-position coding (Perea, Panaderó, Moret-Tatay & Góméz, 2012).

The struggling readers in our study made more medial migration errors than initial-final migration errors, compared to typical readers, which is consistent with the literature on young readers who all showed the crowding effect, with the effect being stronger in the impaired readers (Hawelka & Wimmer, 2005; Martelli, Di Filippo, Spinelli & Zoccolotti, 2009; Spinelli, de Luca, Judica & Zoccolotti, 2002).

An alternative explanation of our findings was proposed by Friedmann and Gvion (2001), who attributed the effect to a more differentiated attention to the various letter positions. They stated that attention is generally first directed towards the initial and final letters of a word, and then to all the medial letters at the same time, a process that is vulnerable to incorrect coding, resulting in more errors.

4.4.4 Dual-Route Model and Letter-Position Processing in Urdu

If we attribute the letter-position effect in Urdu to a differentiated attention to initial, final and medial letters at the orthographic-visual analysis stage of the reading process, the process may then progress as follows: there is preferential attention to a word's initial and final letters, only after which the medial letters are processed, where they are not perceived separately but as a whole without attention to their order. Here, the search for the best match in the lexicon already commences, increasing the risk of an incorrect word being retrieved that has the same letters but where the medial letters are ordered differently. Of all the contenders, the word having the closest orthographic similarity and the highest frequency will supersede the other options and thus becomes the most likely to be produced even if it is an erroneous response.

Although the orthographic-visual analyser appears implicated in migration errors, deficits in two other components of the dual-route model might also be involved. Although Kezilas et al. (2014) strongly favoured the involvement of the orthographic-visual analyser and ruled out the role of the orthographic lexicon and phonemic buffer (for word reading in English) in letter-position errors, and previous evidence (Friedmann & Rahamim, 2007; Kezilas et al., 2014; Kohnen et al., 2012) and our findings also seem to favour the involvement of the orthographic-visual analyser in migration errors, further research into migration errors in Urdu that investigates the potential roles of the orthographic lexicon and phonemic buffer with targeted stimuli is recommended.

4.5 Conclusion

Although at first glance it might seem difficult to learn to read Urdu considering its position-dependent multiple letter shapes, our results indicate the opposite. Given the higher accuracy for cognates in which the letters changed shape when they changed position, this feature of Urdu appears to facilitate letter-position processing. In comparison to orthographies like English where letter shapes are not position-dependent, Urdu might then be easier to process for readers suffering from LPD. However, since we looked at struggling readers that had not been formally diagnosed due to the absence of validated tests, we were unable to test this hypothesis.

To evaluate letter-position processing in beginning readers of Urdu further, and as we found greater differences in the performance of the typical and struggling readers in these conditions, we propose targeted studies in which impaired and unimpaired readers are assessed with low-frequency, same-shape cognates that have the potential for medial-letter migrations while response and reading times at item-level are recorded. Investigations of this nature will further uncover the complex mechanisms of letter position processing in Urdu and other orthographies.

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CHAPTER 5

General Discussion

Reading is an important skill, not only for academic achievement but also for lifelong learning and successful socio-economic participation. In contrast to speech, reading requires explicit instruction. Traditionally, children first learn to read in primary school, where those speaking transparent languages, such as Spanish or Finnish, are generally able to read quite accurately after one year of formal instruction (de Jong & Van der Leij, 1999; Seymour et al., 2003). However, mastering advanced levels of reading fluency takes much more time (Landerl & Wimmer, 2008). In languages with deep(er) orthographies, such as English, children may even need more time of instruction to acquire the same degree of reading accuracy as children learning to read transparent orthographies (Seymour et al., 2003).

Despite adequate instruction, favourable circumstances, and individual differences that characterize normal variance in reading, a substantial number of children experience serious problems attaining adequate and fluent reading skills. These children may be suffering from dyslexia. This common learning difficulty affects approximately 3 to 10% of the population worldwide (Pennington, 2012), where the prevalence depends on the degree of transparency of the orthography being learned (Ziegler & Goswami, 2005). Exact estimates of children with reading difficulties or dyslexia in Pakistan (the setting of our study) are not available. A recently conducted early-grade reading-assessment survey did indicate that the majority of primary schoolchildren in Pakistan read English and even Urdu, the native language of many children, far below the age-appropriate level or cannot read at all (Research Triangle Institute, 2015-16). If not timely remediated, reading difficulties will persist, with the disparity between typical and struggling readers growing bigger over time (Adolf, Catts & Lee, 2010). The persistent and worsening problems will affect the child's academic, personal and social life, which is not only detrimental to the child and its immediate environment but also adds to the social burden of dyslexia.

5.1 Development and Evaluation of a Dyslexia Assessment Battery for Urdu

A sound theoretically-based assessment of reading deficits is crucial for effective remediation and was the main motivating factor for the studies presented in this thesis. Our studies on Urdu have permitted us to advance knowledge and practice in the field of dyslexia in this widely spoken language.

We developed a dyslexia assessment battery for Urdu-speaking children and administered the tests on typical and struggling readers aged 7 to 11 years, thus gaining a deeper insight into the nature of the typical and impaired reading-acquisition processes in Urdu (**Chapter 2**). In doing so, we also tested the applicability of the dual-route model (DRM) for reading aloud to this novel orthography (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). We found our dyslexia test battery to be highly reliable and valid for the identification of children with reading and/or spelling deficits (based on the DSM-5 criteria) in Urdu. Moreover, the battery was shown to be suitable for the screening of large groups of beginning readers. Our tests also confirmed the diagnosis in children who had been diagnosed with dyslexia in English prior to our study.

When we applied the cut-off score proposed by the DSM-5 ($<$ Pc 16) on the whole sample (typical as well as struggling readers), it led to 60% false negatives: only 50 of the 128 struggling readers we tested were screened out as positive. We came up with the argument that this disproportionately high number of false negatives was a result of including struggling readers in the population from which we derived our cut-off score. The assignment of the struggling readers in our study was based on teachers' and parents' referral, hence subjective. Therefore, the label 'struggling reader' may not necessarily have reflected the children's actual reading and/or spelling abilities. Some of the children may have had other reading or language-related difficulties, such as problems with text comprehension, or may perhaps even have been suffering from other learning deficits. Also environmental factors (inadequate language instruction, parental illiteracy), behavioural issues (ADHD) and/or cognitive factors (slow learner, short memory span) may have played a role. Although these conditions do not cause dyslexia, all these factors are known to often co-occur with dyslexia.

A second potential explanation for the high volume of false negatives is the arbitrariness of the diagnostic cut-offs in this condition. Dyslexia is not a distinct category but reflects

deficits at the lower end of the 'reading-abilities' continuum (Shaywitz, Escobar, Shaywitz, Fletcher & Makuch, 1992). In-line with this 'lower end of reading-abilities' hypothesis we applied the cut-off scores again, and this time to the group of typical readers only, excluding the struggling readers, and the sensitivity of our test increased, ranging from 76 to 89 percent for different tests. Accordingly, it is impossible to make an unambiguous and categorical distinction between those who have and those who do not have dyslexia (Ellis, 1984). Every cut-off point to separate typical from dyslexic readers is somewhat arbitrary and susceptible to critique (e.g., Pennington, 2006). Cut-off values vary from study to study depending on the definition of dyslexia that is adopted (Siegel, 2006). Shaywitz et al. (1992) argued that dyslexia should not be viewed as an 'all-or-none entity' but as a condition that varies in terms of severity. This ambiguity does not question the reality of dyslexia, but does indicate the subjectivity in its diagnosis. Nevertheless, for an adequate diagnosis and referral for treatment, a cut-off point is a practical necessity (Siegel, 2000).

The second motive driving our studies was the wish to understand the key patterns that underlie typical and impaired reading processes in Urdu. Our test distinguished well between typical and struggling readers, with high effect sizes, showing that the latter group was most severely impaired in spelling accuracy, followed by reading accuracy. This co-occurrence of spelling and reading impairments is consistent with previous literature (Bosman & Orden, 1997; Frith, 1980; 1984; 1985; Mehta et al., 2005; Moats, 2005; Mommers, 1987; Nicolson & Fawcett, 1994; Seymour & Porpodas, 1980; Thomson, 1984) and in congruence with the DSM-5 definition of dyslexia that we adopted for our research (American Psychiatric Association, 2013), which states that dyslexia is a specific learning disorder that affects reading and/or spelling abilities. The effect sizes for reading speed were also very high, affirming that reading speed is one of the main problems in the majority of children with dyslexia. More about the pattern of deficits can be found in the discussion of Chapters 3 and 4.

Our third research objective was to explore the applicability of the dual-route model (DRM) of reading aloud (Coltheart et al., 2001) to Urdu. Since our test battery gauged single and multiple deficits in the functional components of the DRM, we could test its applicability to Urdu. The high discriminatory ability of our test, between typical and struggling readers as well as within struggling readers, was indicative of DRM's relevance (Chapter 2). The DRM proposes two distinct routes for reading: an indirect and a direct route. Through the indirect route, reading occurs by converting letters into sounds, while through the direct route, the visual word form of a word is directly processed without breaking it up into sounds. Consistent orthographies are more easily processed by means of the indirect route than inconsistent orthographies that do not have one-to-one letter-to-sound mapping.

Urdu is both consistent when fully written out with vowel markers or diacritics (Mumtaz & Humphreys, 2001) and inconsistent when the diacritics are omitted. This fluctuating orthographic-depth makes Urdu an interesting language in which to study typical and struggling readers. In the study reported in Chapter 3, we conducted an in-depth investigation of the reading profiles of these two groups by manipulating orthographic transparency, in that we compared their performance when reading words with and without diacritics, and lexicality by comparing their performance on words and pseudowords. By manipulating these two orthographic features, we sought to probe lexical and non-lexical processing in Urdu to thus determine which of the two routes beginning readers rely on most and to see whether strategies would differ between typical and struggling readers.

5.2 Inconsistencies in the Urdu Orthography

Similar to Arabic and Persian, the presence or absence of diacritics render the orthographic depth of Urdu inconsistent. Initially (i.e. in grades 1-2), children in Pakistan are taught to read using the shallow orthography (with diacritics), but as early as from grade 2 reading and textbooks no longer include these vowel markers (Rao et al., 2010). The children participating in our study were attending grades 3-7 and were hence mostly exposed to the deep orthography (without diacritics).

The results of our second study (**Chapter 3**) unequivocally showed that both the typical and struggling readers displayed a more accurate and faster performance on opaque words (without diacritics, having one and more than one correct pronunciation) than on transparent words (with diacritics), which is indicative of the transparency effect, as well as on words compared to pseudowords, demonstrating the lexicality effect. We found evidence of the transparency and lexicality effects, i.e. a preference for the direct or lexical route (visual word recognition) over the indirect or non-lexical route (letter-to-sound conversion), which is consistent with previous studies that have also found a preference for the direct route in Arabic-speaking individuals reading non-diacritic script (Frost et al., 1987; Roman & Pavard, 1987; Tabossi & Laghi, 1992). Our results suggest that both typical and struggling readers of Urdu were slowed down by the presence of diacritics, with the effect being most pronounced in the impaired readers suggesting a phonological deficit in this group.

As argued in **Chapter 3**, diacritics make words visually more complex and create a higher perceptual load, slowing down the reading process (Abdelhadi, Ibrahim & Eviatar, 2011; Taha, 2008). Because our stimuli were not selected with the specific aim of isolating these effects, we will be using targeted stimuli in future investigations. Alternatively or additionally, the delay in reading may have been caused by the children's unfamiliarity with diacritic Urdu script. Given that they are far less exposed to the shallow orthography, this might explain why we did not find a facilitating effect of the higher orthographic transparency. Consistent letter-to-sound mapping encourages processing via the phonological route but Urdu print, to which children are exposed after grade 2, does not allow consistent mapping, forcing the children to process words through the whole-word recognition route.

Our results were consistent with those of Rao and colleagues (2011), who compared speakers of Urdu (inconsistent orthography) and Hindi (consistent orthography) in a lexical-decision and word-naming task. They found a lesser use of the phonological route

when Urdu was being read. The authors explained this difference in terms of the varying orthographic depth of Urdu resulting from the presence or absence of diacritics. They also found stronger word-frequency effects in Urdu than in Hindi, which is also in line with our findings. If, as discussed, Urdu readers primarily rely on the visual word recognition route, it would be expected that high frequency words would be recognized better than low frequency words. More support for their and our findings comes from the countrywide baseline Early Grade Reading Assessment (EGRA-USAID) conducted between 2013 and 2014 in Pakistan. This survey found scores to be better for familiar words than for pseudowords in all the provinces of Pakistan. All of these findings converge into a conclusion that Urdu readers primarily employ the visual-word recognition method to read as letter-to-sound conversion seems less developed, especially in struggling readers.

One of the reasons for the dominant use of the direct route in learning to read Urdu could be the rote-learning method that is widely used in the educational system in Pakistan. By rote learning we mean the memorisation of whole words through repetition, where words are not broken down into sounds. Even before formal reading instruction starts, children are exposed to the visual word forms through 'Beginning Qaida', one of the introductory reading books used for children aged 3-5 years in pre-nursery, nursery and kindergarten settings. In Figure 5.1 below, we provide an example of beginning reading material in Urdu.

Figure 5.1: A page from Beginning Qaida (Urdu preschool reading book). The 'ا' (/ə l ɪ f/ - the first letter in the Urdu alphabet given at the top of the page in red) is presented together with four pictures representing words starting with this letter (without diacritics).

Figure 5.1 shows a page from a beginners' reading book, introducing the letter *alif* (ا), the first letter of the Urdu alphabet, along with four pictures of objects starting with this letter. *Alif* is a vowel and represents various sounds depending on whether it is placed at the beginning, middle and/or end of a word. At the beginning of a word, it is used with diacritics to indicate three short vowel sounds '/ə/', '/ɪ/' and '/ʊ/'. If it is followed by either the letter wā'o (و) or ye (ی) it designates long vowel sounds (e.g. '/oː/'). A variant of *alif* called *alif madd* (آ) connotes the long vowel sound '/aː/' also at the beginning of a word. In the middle of a word, the same sound '/aː/' is denoted by the *alif* (ا) only. The variety of sounds associated with *alif* is depicted in Table 5.1.

Table 5.1: Examples of sounds associated with the letter 'alif'

Transliteration	IPA	The letter alif
A	/ə/	اَ◌
I	/ɪ/	اِ◌
U	/ʊ/	اُ◌
Ā	/aː/	◌ا ◌ا◌ آ◌
e	/eː/	ای◌
o	/oː/	او◌
au	/ɔ/	اَو◌

Note. Dotted circles are given to clarify the position of the alif.

In Figure 5.1, at the bottom left, a word اُونٹ (camel) is given, which is pronounced as '/uː n ʈ/' where the sound of '/uː/' is represented by a combination of alif (ا), a missing diacritic marker ◌ُ on top of alif (ا) and a letter wā'o (و). However, with the missing diacritic on top of alif this word can also be pronounced as '/oː n ʈ/' which would be a wrong pronunciation. Therefore, for the correct sounds to be inferred, diacritics need to be mentioned. In the same figure at the top right word انار (pomegranate) has the letter *alif* twice in it. The first *alif* is pronounced '/ə/' and the diacritic that should have been placed above the vowel is missing, which is why a beginning reader would not know whether the correct sound is '/ə/', '/ɪ/' or '/ʊ/'. Therefore, unless the correct diacritic marker is there it can be pronounced in three different ways: '/ə n aː r/', '/ɪ n aː r/', '/ʊ n aː r/'. In most schools in Pakistan, the letters are not introduced with diacritics and letter sounding and blending rules are not explicitly taught to beginning readers. Rather, children learn to link the pronunciation of a word to its visual form by repeating and memorising the pronunciation of the whole word.

The effects of this practice are reflected in the fact that in our study reported in Chapter 3 all children generally performed poorer when reading pseudowords and words with diacritics than when pronouncing words without diacritics, where the effects were larger in the struggling readers. Support for this argument is also found in the EGRA-USAID (2013-2014) conclusions, where the poor performance of beginning readers on pseudoword reading, letter-sound knowledge and phonemic awareness was attributed to rote learning and the lack of proper instructions on letter sounds. Moreover, comparing words and pseudowords in Urdu, Rashid et al. (2010) also found that response times and

error rates were significantly increased for pseudowords compared to words, which further supports our conclusions.

Indeed, in Pakistan reading instruction is generally not based on teaching phonics, except in a small number of private schools where only English letters (not Urdu letters) are introduced with the phonics method. The absence of phonics instruction was also highlighted by Nawab (2012) who emphasised the need for a proper training of phonic rules for primary school teachers. He argued that children's poor reading performance could be largely explained by inadequate introduction to letter-sound associations and rules. For example, in Figure 5.1 again, at the top right a word انار (pomegranate) has the letter *alif* twice in it, the first *alif* is pronounced '/ə/' and the second *alif* is pronounced '/aː/' – a long vowel sound. So the pronunciation of انار is '/ə n aː r/'. If the young reader is not familiar with the letter-sound association rule that *alif* has a long vowel sound when it is used in the middle of a word, s(he) may incorrectly pronounce it as '/ə n ə r/'. Therefore, children need to be taught the letter-sound association rules depending on the position of letters in order to pronounce them correctly. Interestingly in Urdu, when a position of a letter is changed within a word, not only the sound but the shape of it also changes - a phenomenon known as letter position effect which we will cover in detail in the next section.

5.3 The Effect of Letter Positions in Learning to Read Urdu

Our third study revolved around the letter-position effect in Urdu (**Chapter 4**). We explored the difficulties beginning readers face in positioning and ordering letters into words. Letter positioning is one of the three functions of the orthographic-visual analysis system of the DRM. In the Urdu alphabet, letters change shape according to their position in a word, for instance, the letter 'غ' /ɣ/ in isolated form has three contextual forms: initial غـ , medial ـغـ and final ـغ .

We examined reading accuracy in the same sample of typical and struggling readers that participated in our other studies and found that both groups performed better when reading words in which letters changed shape depending on their positions than when they read cognates in which the shape of the letters remained the same. This tendency was found to be significantly greater in the struggling readers than it was in the typical readers. Intuitively, multiple letter forms may pose difficulties in reading but, surprisingly, we found position-dependent letter changes to be a facilitating factor in Urdu. We also found a high migration tendency in low-frequency words compared to their high-frequency cognates. This trend was observed in both groups but again significantly more so in the struggling readers. Finally, there were fewer migrations of initial and final letters compared to middle letters, a difference which was also greater for the struggling readers.

Overall, the pattern of errors was the same in both the typical and struggling readers in that all children made more errors when reading same-shape, less frequent words, and words with the potential for medial letter migrations. Still, the large group differences in accuracy and speed indicated that these problems were severely aggravated in the struggling readers. We obtained close-to-ceiling accuracy proportions for the typical readers (M >85%) but a dramatic drop in the accuracy of the struggling readers (M <50%). Therefore, we suggest that words with the potential for these particular letter migrations could be used to test for specific cases of letter position dyslexia as children with this type of dyslexia have been reported to exhibit issues with letter positioning in particular, while other reading- and spelling-related functions of the DRM remain intact (Friedmann & Rahamin, 2007; Kohnen et al., 2012). The literature also shows evidence (Friedmann & Gvion, 2005; Friedmann & Haddad-Hanna, 2012) that, as a function of the orthographic-visual analysis system, letter identification can develop normally even when letter-position encoding is selectively impaired. Further investigations to test this claim for Urdu are crucial, as, if proven true, remediation can be targeted better. Children may then, for instance, be trained to attend each letter of a word to help them prevent making letter-position errors (Rahamim & Friedmann, 2003).

Assimilating our findings from this study (Chapter 4) with the previous ones (Chapter 2 and 3) we found further support for our argument regarding Urdu readers primarily relying on the visual word recognition as a reading method. Most probably this is why the words that looked more similar to each other (same-shape) were more prone to errors than the ones that did not look similar (changed-shape) and thus were easier to correctly recognize. Moreover, as in the previous study (Chapter 3) we found the frequency effect again for reading accuracy and speed, with high frequency words being recognized better and faster than low frequency words. Furthermore, unlike letter-to-sound conversion, in visual word recognition attention is directed towards the initial and final letters and then together to the medial letters thus resulting in more migration errors in reading medial letters (Friedmann and Gvion, 2001).

5.4 Towards a Complete Diagnostic Protocol for Dyslexia in Urdu

The usefulness and accuracy of a reading or dyslexia test battery depends upon its potential to provide a comprehensive assessment covering three diagnostic categories, namely a categorical, explanatory and an action-oriented diagnosis (Kleijnen et al., 2008). We will next evaluate to what extent our test fulfils these standards by discussing its strengths and weaknesses. Is our test comprehensive and, if not, what changes are needed?

The results of our study indeed showed that our test battery meets the first requirement in that it provides a categorical diagnosis, often referred to as a descriptive diagnosis. That is, it gives a conclusive outcome indicating whether an individual meets the criteria of dyslexia (e.g. those of the DSM-5) and thus belongs to a clinical group. The test was reliable and valid and met the dyslexia criterion (cut-off < Pc 16) as corroborated by the fact that it confirmed the diagnosis of the children that had been diagnosed with dyslexia in English prior to our study. Because of the dearth of dyslexia screening and diagnostic materials for Urdu, we were unable to include children that had already been specifically diagnosed with dyslexia in Urdu. As ours is the first dyslexia assessment test for

Urdu-speaking children and since we evaluated its effectiveness in children aged between 7 and 11 years attending private middle-income schools, its generalisation is limited for now. However, we expect the test to be suitable for children from different socioeconomic backgrounds attending other types of schools. We plan to administer the battery to a wider population to standardise the test and develop age-appropriate norms.

Our dyslexia test also seems to fulfil the second requirement in that it provides an explanatory diagnosis, linked to the DRM of reading, and thus allows clinicians to make a judgement about the underlying factors contributing to the reading and/or spelling impairments of the individual tested and to recommend targeted remediation. We based our test on the DRM and in addition, to reading-related and associated cognitive factors, hence it yields a profile of a child's abilities and deficits on a number of factors including letter identity recognition, letter order processing, letter-sound identification, phoneme and syllable blending, word recognition, reading and spelling skills, vocabulary and rapid naming.

We also found indications that our test affords an action-oriented diagnosis in that it provides differential clues for remediation. It does not only distinguish well between typical and struggling readers at group level, but also provides the opportunity to see if children have certain subtypes of dyslexia through detailed profiling of specific strengths and weaknesses. Through this detailed profiling one can really focus on the problematic areas in the reading development of these children and can provide better remediation and treatment. For instance, our results (Chapter 2) showed that some struggling readers in our study had issues with pseudoword reading while having their word reading through recognition intact. The number of children who exhibited this pattern was more than the inverse condition.

Consequently, we were able to infer from the results we obtained that in the participating and possibly other Pakistani schools there are shortcomings in early reading instruction, most notably in early phonics instruction. With our test battery, existing teaching methodologies can be evaluated more in detail and evidence-based strategies can be developed to improve early reading instruction. Teachers may be supported in making their teaching practices more effective for all pupils, while they may be additionally trained in techniques to address specific reading issues of particular pupils. Outside the classroom and based on the test outcomes, parents may also be more involved in their child's reading development by providing them with tailored strategies to help their child handle the difficulties he or she is facing.

5.5 Practical Implications for Pakistani Schools and Future Directions

Around the world, remedial systems for children with dyslexia are being developed, refined and implemented. Despite a growing awareness, these reading and spelling difficulties have not received the priority they deserve in Pakistan. In allocating the scarce resources available for public services, low priority has been given to issues such as dyslexia.

Recently, there was an attempt to change this situation, however. In an effort to improve the reading status of children in Pakistani schools, a countrywide baseline survey was conducted (EGRA-USAID, 2013-14).

As soon as norms have been established, our newly developed reading assessment battery for Urdu can be used to reliably identify and classify struggling readers. This puts us in the position to systematically evaluate reading and spelling instruction methods. As our results showed that the children we tested rely more on visual word recognition than on phonological decoding, whole-word methods can be compared to decoding-oriented methods. The outcomes of such a systematic investigation may inform us about the most adequate instruction methods for beginning readers of Urdu in general and for those who show marked phonological deficits in particular. Along the same lines and connected to the phonological deficit issue, it seems already viable to conduct interventions to remediate decoding issues, the effects of which can be evaluated with pre- and post-assessments. One such potentially highly effective remedial programme is called GraphoGame (GG). This computer-based game facilitates the individual young learner in acquiring basic literacy skills and can also be used to gather reading-related information from a large number of children for research purposes (Richardson & Lyytinen, 2014). Thus it would be highly suitable to teach Urdu-speaking children the phonics approach that appears indispensable for boosting their reading skills.

A standardised reading assessment test will also open the doors to recently developed response-to-instruction models (RTIs), which are considered today's 'gold standard' for effective remediation (Fuchs & Fuchs, 2006). Rather than waiting for struggling children to fail at school and for them to be classified as needing help, RTI methods test whether these children have a reading difficulty before they start experiencing its (long-term) consequences and assesses how they respond to an instructional intervention. Classically, in primary-school settings, RTIs start with a screening of all students, for which our battery could be used. When its outcomes indicate problematic areas or deficits in the reading performance of groups of or individual students, an intervention may then be developed to remediate the reading issues at this early stage.

To expedite such an initial screening programme in Pakistan, we will be developing a digital version of our test battery and will make it available online, while linking it to a data-collection platform to also enable us to establish the prevalence of dyslexia within the population with sufficient precision to be useful for the development of remedial care services. Online screening will also allow us to determine the specific prevalence rates per type of school (private, public, community, etc.), variations across age, gender and socio-economic status and thus the type of services needed (e.g. remedial teaching, counselling, parent management training, medication, or cognitive-behavioural therapy), and where these are needed most to set up service facilities in the areas with the highest prevalence of dyslexia.

The next step in such an RTI model is to conduct periodic assessments in at risk groups (e.g. in the 25% weakest readers) to monitor progress and the effects of interventions. Remediation or care services can then be adapted to the individual needs of

the struggling reader. To monitor and enhance children's reading performance, assessment and intervention can also be provided in a digitally game-based and age-dependent learning environment addressing various specific problems in letter-word reading at increasing levels of difficulty. Non-responders can then be diagnosed as having dyslexia at an early stage and referred for targeted treatment.

Clearly, any RTI model should not only be diagnostic but primarily remedial in nature. Moreover, the beneficiaries of RTIs are not only the children themselves. Parents and teachers are other important stakeholders, as well as the community at large, especially in the longer term. RTI models should hence be multifaceted and not only comprise sound assessments but also targeted interventions and counselling for the at-risk and struggling beginning reader as well as training, instruction and support for teachers and parents.

Appendix

Overview of the tests

Functions/ Factors	Tests	No. of Items	Description and Administration of tests
Letter Identification	Letter-Name Knowledge	20	Active Naming (Child sees the letter and has to tell the name of that letter)
Phonemic Awareness	Letter-Sound Knowledge	20	Passive Naming (Investigator says the sound and child has to point towards the correct letter) Both these tests provide give accuracy scores.
Phonological Awareness, Sound-blending, Retention	Phoneme and Syllable Deletion	30	In this test, the investigator asks the child to delete either the initial, middle or final phoneme/syllable of an orally presented word and then produce the remaining word. This is the only oral test in the battery. It consists of 30 items, ten items each for initial, medial and final phoneme and/or syllable deletion. In all the three sets, words are equally represented in terms of one, two and three syllables. This test provides accuracy scores.
Reading	Word Pairs (Letter Position)	25 25	Taps the ability to code the order of letters in words by reading words in which the initial, middle or final letters have been swapped around. Testing material consists of 50 words, in the form of 25 pairs making two individual lists of words. Child reads list one first (25 words, including one word from each pair) and then list two. This test provides accuracy scores as well as reading speed (measured over the whole list).
Decoding Skills (Letter-Sound)	Pseudoword Reading	30	Gauges knowledge of the relationship between Urdu letters and sounds. Child reads aloud 30 pseudowords that cannot be read by whole-word recognition. These pseudowords are presented with vowel markers (diacritics), so that the children have the information to read the words aloud correctly as long as they know the correspondence rules. The words are ordered in terms of difficulty level (1, 2 or 3 syllables). This test provides accuracy scores and also reading speed.
Visual-word Recognition	Word Reading (1 reading possibility)	30	Checks whole-word recognition skills. Child reads 30 words aloud. Words included are without their vowel markers (diacritics) so they cannot be read correctly unless the child is familiar with the word. There is only one correct pronunciation of each word included in this test. Half of the words are high frequency words and half low frequency words. The words are also ordered in the test according to their difficulty level. There are ten items with one, ten with two and ten with three syllables. Out of the ten words in each category of syllables half of them are high frequency and half low frequency words. This test provides accuracy scores and also reading speed.
	Words without Diacritics (2 or 3 reading possibilities) Words with Diacritics	30 30	It gauges child's choice of route to process words with and without complete phonological information (inclusion or exclusion of diacritics respectively). This test consists of 30 words once presented without and again with diacritics in random order. So, there are two lists consisting of (1) words with diacritics (only one possible reading due to diacritic markers) and (2) the same words without diacritics, each having 2 (or 3) possible readings. This test provides accuracy scores and also reading speed.
Spelling skills	Words Pseudowords	15 15	Assesses child's spelling abilities. Investigator says the word and child writes it down on a blank sheet of paper. There are total 30 words in this test, 15 are words, arranged in the order of difficulty (1,2 and 3 syllables) and remaining 15 are matching (same no. of syllables) pseudowords with diacritics. Five words have single syllable, another five have two syllables and remaining five are three syllable words. For word spelling section, in each category of syllables, high and low frequency words are included. This test only provides accuracy scores.
Word-Meaning Knowledge	Vocabulary	62	This test assesses knowledge of the meanings of words. It consists of 62 items. Each item consists of four pictures. The test administrator says the word aloud and the child has to point to the correct picture. Out of the four pictures (pasted on one page), one is the target picture and rest are: a phonological distracter (having the same initial phoneme as target word), a semantic distracter (having similar meaning as target word) and an unrelated picture. This test gives accuracy scores.
Rapid Automatized Naming (RAN)	Colours Objects Digits English Digits Urdu	35 35 35 35	This test involves rapid naming of four stimuli sheets one-by-one, as accurately and as quickly as possible. Four stimuli sheets are of colours, objects and digits (one for English, one for Urdu). Both the digit sheets include numbers from 1-9 and are presented in different order in both sheets. This test only provides accuracy scores.

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Summary

Reading is an important skill, not only for academic achievement but also for lifelong learning and successful socio-economic participation. In contrast to speaking, reading requires explicit instruction. However, a substantial number of children experience serious problems attaining fluent reading skills despite adequate formal instruction and favourable social and learning conditions and after individual differences underlying the normal variance in reading have been accounted for. Some of these struggling children may then be suffering from dyslexia, a learning disorder that affects approximately 3 to 10% of the population worldwide (Pennington, 2012). To minimize the detrimental effects of the disorder, it is important to provide early intervention, making timely and adequate assessment indispensable.

In the general introduction (**Chapter 1**) of this thesis we established the need for a thorough assessment of reading and spelling difficulties in Urdu-speaking children. Urdu, one of the national languages in Pakistan belonging to the Indo-European family, has about 588 million speakers worldwide; for around 100 million it is their first language. Even though it is widely spoken around the world, Urdu still is an under-researched language. It is explained why and how we can adopt the dual-route model (DRM) of reading to assess Urdu reading processes and impairments. The Urdu script is cursive in nature

and is written from right to left. It has some uniquely interesting features that need to be taken into account to better understand skilled and impaired reading in Urdu. First, many letters are visually similar and can only be differentiated in terms of the presence, number and position of dots and/or strokes {e.g. ج (/d͡ʒ/) , چ (/t͡ʃ/) , ح (/h/, /ɦ/) and خ (/x/)}. Second, one sound is represented by more than one letter (e.g. /s/ ث ، ص ، س and /z/ ض ، ذ ، ز ، ظ). Third, the Urdu language has a fluctuating orthographic depth due to the inclusion and exclusion of short-vowel markers or diacritics. It has regular spelling-to-sound correspondences when fully written out with diacritics but when these are left out successful word identification happens with contextual help. And finally, in Urdu letters change shape according to their position in a word. For instance, the isolated form 'غ' (/ɣ/) can be written as غـ ـغـ and ـغ in initial, medial and final positions, respectively. Given these characteristics and since in Pakistan tests to diagnose reading and spelling deficits are mostly based on English tests, there is a dire need for a dedicated test battery that assesses basic literacy skills in Urdu in the early stages of reading acquisition in order to allow the timely identification and remediation of reading difficulties.

Chapter 2 covers the development and validation process of our Urdu reading/dyslexia test battery. The broad aim of this first study was to try to understand the nature of typical and impaired reading processes in Urdu. Our specific objectives were: (1) to develop a test battery to assess reading problems in Urdu; (2) to understand the deficient patterns in key reading processes by comparing young struggling readers of Urdu with typically developing peers; and (3) to test the application of the DRM to Urdu. With our tests we sought to identify reading difficulties (potentially indicative of dyslexia) in young children first learning the Urdu orthography. The choice for and content of each test is described in detail, as well as their validity and reliability, along with the results of our group comparisons (typical vs. struggling readers). Taking the DRM of reading and existing dyslexia batteries in other alphabetic languages as our lead, we designed tests to assess letter knowledge, word and pseudoword reading and spelling, and phonological abilities. These were subsequently administered to 167 typical readers (TR) and 128 struggling readers (SR) aged 7-11 years (grades 3-7; 150 boys, 145 girls) to establish their reliability and validity, to create profiles of the reading-related cognitive functions of proficient and struggling readers, and to test the applicability of the DRM. Test reliability and validity were very high. Overall, correlations of the accuracy and speed measures confirmed the test battery to have high construct validity. All TR-SR differences were significant ($\alpha = .01$) in detriment of the SR group. Effect sizes (ES) were the highest for the spelling measures ($g > 2$), followed by the reading measures, where ES for accuracy ($g > 1.50$) were higher than those for speed ($g = 1.07$ - 1.45) and ES for pseudoword reading and spelling ($g > 2.5$) higher than those for word reading and spelling ($g = 1.59$-2.37). The medium ES for rapid automatized naming (RAN) and vocabulary were lower than those for reading and spelling. Based on these results, we concluded that our DRM-based test battery was reliable and valid, and differentiated well between proficient and struggling readers, confirming that the DRM of reading was indeed also applicable to Urdu.

Certain features of Urdu, such as its dual orthography and the fact that alphabetic letters can change shape according to their position in a word (the letter-position effect),

make it an interesting language to study. In **Chapter 3** we elaborated on the dual orthography by studying the effects of inconsistencies in written and spoken Urdu resulting from the presence or absence of diacritics. Urdu orthography is transparent when written with diacritics (denoting short vowels), leading to a one-to-one letter-sound correspondence, and opaque without them, when letters correspond to more than one sound. We explored transparency and lexicality effects by comparing the reading performance (in terms of accuracy and speed) of typical and struggling Urdu readers. We tested the same sample of children (that participated in our study described in Chapter 2) on 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. All children read the 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. It was clear that both the typical and the struggling readers relied more on visual word recognition than they did on letter-to-sound conversions. We also posited that a phonological deficit appears to explain the reading-related issues in struggling readers of Urdu, which was evident from their significantly poorer and slower performance on reading/decoding tasks comprising words with diacritics and pseudowords compared to typical readers.

Chapter 4 revolves around the letter-position effect. In the study presented we sought to understand the effect of the Urdu orthography on letter-position processing in beginning readers. Being cursive in nature, an intriguing aspect of the Urdu orthography is that many letters change their shape according to the position they take in a word. Using the same groups of beginning readers that took part in our earlier investigations (Chapters 2 and 3) and hypothesizing that reading accuracy scores would be higher for words with changed-shape migrated-letter cognates as compared to when the shapes of the letters remain the same, we expected this to be true for both the typical and the struggling readers but more so for the latter group. We additionally investigated word-frequency effects and differential effects between migrations of initial and final letters compared to migrations of middle letters. Exploring how letters are processed by the orthographic visual-analysis component of the reading system that is responsible for the determination of the position of letters, we investigated whether a change in shape would facilitate or hinder the ordering of letters within Urdu words. To find out whether we would find differential letter-position effects for the typical and struggling readers, we manipulated the shape, frequency and position of letters in words such that the effects of these manipulations on letter processing could be compared for the two groups. Two lists of 25 words each in which letters varied in shape, frequency and position were presented to be read aloud. Compared to same-shape migrated-letter cognates, reading accuracy was superior for migrated-letter cognates that changed shape due to their new position, as well as for high-frequency words (having low-frequency cognates) compared to low-frequency words (having high-frequency cognates) in both groups. The children were also better at reading words with cognates containing letters that changed initial and final positions compared to words with cognates where letters changed medial positions. Reading accuracy in the struggling readers was, however, always significantly poorer than that of the typical readers. It was concluded that position-dependent letter forms facilitate letter-position processing in both typical and struggling readers of Urdu.

The thesis concludes with **Chapter 5** in which we summarize and discuss all the studies presented. We elaborate on the development and evaluation of our dyslexia assessment battery for Urdu, the inconsistencies in the Urdu orthography, and the effects of changing letter positions on learning to read Urdu. Also practical implications of our findings for Pakistani schools and future directions in the field are proposed. We furthermore investigated whether our reading assessment battery fulfils the criteria of a comprehensive diagnostic protocol for dyslexia in Urdu, concluding that it indeed affords descriptive (categorical), explanatory and action-oriented results. Standardization of the tests is proposed as a next step. Finally, using targeted reading measures to test each component of the dual-route model of reading, we identified reading difficulties in Urdu-speaking children that pertain to the various DRM components that are comparable to the problems found in beginning readers of other alphabetic languages (e.g. English).

Samenvatting

Lezen is een belangrijke vaardigheid die niet alleen essentieel is voor goede leerprestaties en een voorwaarde voor 'lifelong learning', maar ook voor sociale participatie en maatschappelijk succes. In tegenstelling tot spreken vereist lezen expliciet onderricht. Helaas blijkt een groot aantal kinderen hardnekkige problemen te ervaren bij het (vlot) leren lezen ook wanneer het onderwijs toereikend is, sociale en leeromstandigheden gunstig zijn en nadat rekening is gehouden met individuele verschillen die de 'normale' variantie in leesvaardigheid verklaren. Het is mogelijk dat een deel van deze kinderen met persisterende leesproblemen kampt met dyslexie, een leerstoornis die zich voordoet in ongeveer 3 tot 10% van de bevolking wereldwijd (Pennington, 2012). Om de negatieve gevolgen van deze stoornis zoveel mogelijk te kunnen beperken is het belangrijk dat vroegtijdig wordt ingegrepen, waarbij tijdige signalering en een gedegen evaluatie onmisbaar zijn.

In de algemene inleiding (**Hoofdstuk 1**) van dit proefschrift hebben we de noodzaak van een gedegen onderzoek naar en van de lees- en spellingsproblemen bij Urdusprekende kinderen vastgesteld. Urdu, een van de nationale talen van Pakistan behorend tot de Indo-Europese taalfamilie, wordt door ongeveer 588 miljoen mensen verspreid over de wereld gesproken; voor zo'n 100 miljoen sprekers is het hun moedertaal. Hoewel de taal wereldwijd op meerdere plekken gesproken wordt, is er nog steeds weinig onderzocht in het Urdu. Het hoofdstuk beschrijft verder waarom en op welke wijze het zogenaamde 'dual-route model' (DRM) van leesvaardigheid kon worden toegepast om de leesontwikkeling en de tekorten daarin te in kaart te brengen. Urdu wordt van rechts naar links en cursief geschreven. De taal heeft een aantal zeer interessante kenmerken die van belang zijn als we de 'normale' en verstoorde ontwikkeling van leesvaardigheid beter willen begrijpen. Ten eerste lijken veel letters sterk op elkaar en kunnen ze alleen van elkaar worden onderscheiden door de aanwezigheid, het aantal en de positie van stippen en/of streepjes {zoals bij ج (/d͡ʒ/) , چ (/t͡ʃ/) , ح (/h/, /ɦ/) en خ (/x/)}. Ten tweede kan een bepaalde klank door meerdere letters worden aangeduid (bijv. /s/ ث، ص، س en /z/ ض، ذ، ز، ظ). Ten derde heeft Urdu een wisselende orthografische diepte die afhankelijk is van korte klinkertekens, de zogenaamde diakritische tekens, die al dan niet gebruikt kunnen worden. Zo is er sprake van een regelmatige grafeem-foneemkoppeling wanneer ze worden toegevoegd, maar als ze worden weggelaten kan een woord alleen herkend worden aan de hand van de context waarin het wordt gebruikt. Een vierde interessant aspect van Urdu is dat sommige letters van vorm veranderen afhankelijk van hun positie in een woord. Als afzonderlijk teken wordt /ɣ/ bijvoorbeeld geschreven als 'غ' maar als het aan het begin, in het midden of aan het eind van een woord staat respectievelijk als ـغ ـغـ en غـ . Gezien deze kenmerkende eigenschappen en omdat in Pakistan de instrumenten die gebruikt worden om lees- en spellingsproblemen te inventariseren voor het merendeel gebaseerd zijn op Engelse diagnostische tests, is er duidelijk behoefte aan een gerichte testbatterij die de leesvaardigheid van kinderen in Urdu kan evalueren zodat tekorten in de ontwikkeling in een vroeg stadium kunnen worden onderkend en behandeld.

In **Hoofdstuk 2** bespreken we de ontwikkeling en het validatieproces van onze diagnostische leesvaardigheids-/dyslexietest voor Urdu. Het bredere doel van deze eerste studie was om de typische en atypische ontwikkeling van leesvaardigheid in Urdu te doorgronden, waarbij onze specifieke doelen als volgt luidden: (1) het ontwikkelen van een diagnostische testbatterij waarmee stoornissen in de ontwikkeling van de leesvaardigheid in Urdu kunnen worden geïdentificeerd en gekwalificeerd; (2) de deficiënte patronen in leesprocessen in kaart te brengen door goede lezers te vergelijken met zwakke lezers van dezelfde leeftijd; en (3) te onderzoeken of de DRM toepasbaar is in Urdu. Met de tests beoogden wij in jonge kinderen die voor het eerst met de orthografie van Urdu kennis maakten leesproblemen (die mogelijk indicatief waren voor dyslexie) te inventariseren. De keuze voor en inhoud van elke test werd uitvoerig beschreven, evenals hun validiteit en betrouwbaarheid en de resultaten van onze groepsvergelijkingen (kinderen met en zonder leesproblemen). Met de DRM (voor de Engelse taal) en bestaande dyslexietoetsen voor andere alfabetische talen als uitgangspunt ontwikkelden wij tests om letterkennis, het lezen en spellen van woorden en pseudowoorden, en fonologische vaardigheden te evalueren. Om de betrouwbaarheid en validiteit van de afzonderlijke tests te bepalen, profielen op te stellen van de aan lezen gerelateerde cognitieve vaardigheden van de kinderen met en zonder leesproblemen en de toepasbaarheid van de DRM te onderzoeken werd de testbatterij afgenomen bij 167 goede en 128 zwakke lezers in de leeftijd van 7-11 jaar (corresponderend met basisonderwijs groep 4-8; 150 jongens, 145 meisjes). De betrouwbaarheid en de validiteit van de test waren hoog. De inhoudsvaliditeit werd onderbouwd door de hoge correlatie

tussen twee onafhankelijke beoordelingen. De constructvaliditeit van de testbatterij bleek hoog gegeven de sterke correlaties tussen de uitkomsten voor nauwkeurigheid en snelheid. Alle groepsverschillen waren statistisch significant ($\alpha = .01$) ten nadele van de moeizaam lezende groep. De spellingtaken lieten de grootste effectgroottes zien ($g > 2$), gevolgd door de leestaken, waar de effectgroottes voor de nauwkeurigheidsscores ($g > 1.50$) groter waren dan de scores voor snelheid ($g = 1.07$ - 1.45) en die voor het lezen en spellen van pseudowoorden ($g > 2.5$) groter waren dan die voor woordlezen ($g = 1.59$-2.37). De effectgrootte voor 'rapid automatized naming' (RAN) en woordenschat waren middelgroot en lager dan die voor lezen en spellen. Op basis van deze resultaten concludeerden wij dat onze op de DRM gebaseerde testbatterij betrouwbaar en valide was en goede en zwakke lezers accuraat kon onderscheiden, waarmee bevestigd was dat de DRM inderdaad toepasbaar was voor Urdu.

Ondanks dat Urdu over de hele wereld wordt gesproken, is de taal nauwelijks systematisch onderzocht. Bepaalde kenmerken van Urdu, zoals de genoemde onregelmatige orthografie door de aan-/afwezigheid van diakritische tekens en de schrijfwijze van de letters die samenhangt met de plaats die zij binnen woorden innemen (het zgn. letterpositie-effect), maken het een interessant studieobject. In **Hoofdstuk 3** onderzochten we de orthografie van Urdu nader, waarbij we de effecten van de inconsistenties in het geschreven en gesproken woord ten gevolge van de aan- of afwezigheid van diakritische tekens in kaart brachten. Deze diakritische tekens geven korte klinkerklanken aan waardoor de klank van letters overeenkomt met het schriftbeeld (regelmatige grafeem-foneemkoppeling) wat de orthografie van Urdu transparant maakt. Worden ze weggelaten, dan wordt de orthografie minder transparant omdat letters meerdere klanken kunnen aangeven (onregelmatige grafeem-foneemkoppeling). We onderzochten de effecten van deze wisselende grafeem-foneemrelaties en lexicale diversiteit op de leesvaardigheid van dezelfde twee groepen goede en zwakke lezers die aan onze studie besproken in hoofdstuk 2 deelnamen, met nauwkeurigheid en snelheid als uitkomstmaten. Wij gebruikten hiervoor (1) een lijst met 30 woorden *met* diakritische tekens en dientengevolge één enkele correcte uitspraak, (2) een lijst met dezelfde 30 woorden *zonder* deze tekens waardoor de woorden op meerdere (2-3) manieren konden worden uitgesproken, (3) een lijst met 30 andere woorden *zonder* klinkertekens die maar op één manier konden worden uitgesproken (4), en een lijst met 30 pseudowoorden *met* klinkertekens waardoor deze dus ook maar op één manier konden worden uitgesproken. Alle kinderen lazen de woorden zonder diakritische tekens beter dan de woorden met de klinkertekens en woorden beter en sneller dan pseudowoorden. De zwakke lezers scoorden significant lager voor zowel nauwkeurigheid als snelheid, waarbij langere woordlengte en lagere woordfrequentie ook grotere effecten lieten zien op hun leesprestaties dan het geval was bij hun vlot lezende leeftijdsgenootjes. Het was duidelijk dat beide groepen zich meer lieten leiden door visuele woordherkenning dan door grafeem-foneemconversies. We opperden daarnaast dat een fonologisch tekort ten grondslag leek te liggen aan de problemen die de zwakke lezers tijdens het lezen van Urdu ondervonden, wat bleek uit hun significant slechtere en langzamere prestaties vergeleken met goede lezers in lees/decodeertaken die uit woorden met diakritische tekens en pseudowoorden bestonden.

In **Hoofdstuk 4** draaide alles om het zgn. letterpositie-effect. In de beschreven studie trachtten wij de effecten van letterpositie op de leesontwikkeling van beginnende lezers van Urdu in kaart te brengen. Een intrigerend aspect van de cursieve orthografie van Urdu is dat veel letters van vorm veranderen naargelang de plaats die ze in een woord innemen. We onderzochten de effecten hiervan in dezelfde twee groepen die aan onze eerdere studies hadden deelgenomen (Hoofdstuk 2 en 3) waarbij we veronderstelden dat woordparen (cognaten) waarin letters van vorm veranderden beter (en/of sneller) zouden worden herkend (en uitgesproken) dan wanneer de vorm van de letters in de cognaten onveranderd bleef. Dit zou dan voor beide groepen gelden maar vooral voor de zwakke lezers. We keken hierbij opnieuw naar de effecten van woordfrequentie maar ook naar de differentiële effecten van migraties van begin- en eindletters en die van letters in het midden van het woord. We wilden dus weten hoe letters binnen woorden in Urdu worden verwerkt via de visuele woordherkenning, de functie die verantwoordelijk is voor het bepalen van de plaats van letters binnen woorden, en of een vormverandering het ordenen van letters zou bevorderen of juist belemmeren. De vorm, frequentie en plaats van letters binnen woorden werden dusdanig gemanipuleerd dat verschillen in letterverwerking in de twee groepen zichtbaar zouden worden. De kinderen werd gevraagd twee lijsten met elk 25 woorden voor te lezen waarbij de vorm, frequentie en plaats van de letters in de woorden van elkaar verschilden. In vergelijking tot cognaten waarin de letters onveranderd beleven na migratie, bleken woorden waarbij de letters wel veranderden als gevolg van hun veranderde positie binnen het woord door beide groepen beter herkend en gelezen te worden. Dit gold ook voor hoogfrequente woorden (t.o.v. hun laagfrequente cognaten) vergeleken met laagfrequente woorden (t.o.v. hun hoogfrequente cognaten). De kinderen lazen woorden waarvan de begin- en eindletters in de cognaten van plaats veranderden beter dan woorden waarvan de letters in het midden van de cognaten veranderden. Opnieuw waren de nauwkeurigheidsscores voor de zwakke lezers significant lager dan die van hun goed lezende leeftijdsgenoten. De conclusie luidde dat letters waarvan de vorm afhankelijk is van de plaats in het woord het herkennen van letters en klanken in Urdu vergemakkelijkt zowel voor kinderen met en zonder leesproblemen.

Hoofdstuk 5 sluit het proefschrift af met een samenvatting en nabespreking van de resultaten van alle beschreven studies, waarbij we dieper ingaan op de ontwikkeling en evaluatie van onze leesvaardigheids-/dyslexietest voor Urdu, de inconsistenties in de orthografie van Urdu en de effecten van de vormverandering die samenhangen met de plaats van letters binnen woorden op de leesontwikkeling. Implicaties van onze bevindingen voor de onderwijspraktijk in Pakistan worden besproken en aanbevelingen voor toekomstig onderzoek gedaan. Ook wordt bekeken of onze testbatterij voldoet aan de criteria die gesteld worden aan een diagnostisch instrument voor dyslexie in Urdu, waarbij geconcludeerd wordt dat de test inderdaad zowel de gewenste beschrijvende (onderkennende) als verklarende en handelingsgerichte uitkomsten genereert. Standaardisering van de testbatterij wordt genoemd als volgende stap. Tot slot, door gebruik te maken van doelgerichte leestaken die elk deelproces van het 'dual-route model' van lezen toetsen, waren we in staat de problemen die zich voor (kunnen) doen bij de ontwikkeling van leesvaardigheid in Urdusprekende kinderen nader in kaart te brengen. De geobserveerde leesproblemen bleken vergelijkbaar met de problemen die men ook in beginnende lezers van andere alfabetische talen (waaronder het Engels) heeft aangetroffen.

Abstract

Urdu is spoken by more than 500 million people around the world but still is an under-researched language. The studies presented in this thesis focus on typical and poor literacy development in Urdu-speaking children during early reading acquisition. In the first study, we developed and validated a series of tests to assess reading and reading-related skills in Urdu, resulting in a test battery to diagnose dyslexia. For an in-depth understanding of the nature of typical and impaired reading processes in Urdu, in next two substudies the dual-route model (DRM) was adopted.

In the first substudy we elaborated on the dual orthography of Urdu due to the presence or absence of short vowel markers or diacritics. We investigated this transparency effect as well as lexicality effects in terms of the DRM by measuring accuracy and speed of reading of (a) words with and without diacritics and (b) words and pseudowords. We found that both the typical and struggling readers preferred the visual word-recognition route over letter-to-sound conversion.

Our final study addressed the letter-position effect resulting from the fact that in the Urdu orthography many letters change shape according to their position in a word. We found reading accuracy to be higher for words in which migrated letters changed shape as compared to same-shape cognates. This was again true for both the typical and the struggling readers but more so for the latter group.

We conclude that the test battery allows for diagnosing and profiling the reading skills and deficits of typically developing and struggling readers in Urdu.

Abstract

Urdu wordt wereldwijd door meer dan 500 miljoen mensen gesproken maar de taal is weinig onderzocht. De studies in dit proefschrift onderzoeken de vroege typische en atypische ontwikkeling van geletterdheid in Urdu-sprekende kinderen. In de eerste studie wordt een reeks tests ontwikkeld en gevalideerd om de leesvaardigheid en andere aan lezen gerelateerde vaardigheden te evalueren, culminerend in een diagnostische testbatterij voor dyslexie voor Urdu. Teneinde de aard van een normale en een verstoorde leesontwikkeling beter te doorgronden werd in twee substudies het 'dual-route model of reading' (DRM) toegepast.

In de eerste substudie gaan wij nader in op de orthografie van Urdu. We onderzochten de effecten van de aan- en afwezigheid van de kenmerkende diakritische tekens (korte klinkertekens) op de herkenbaarheid en betekenis van woorden waarbij wij de nauwkeurigheid en snelheid toetsten tijdens het oplezen van (a) woorden met en zonder diakritische tekens en (b) woorden en pseudowoorden. Het bleek dat zowel de goede als de zwakke lezers visuele woordherkenning verkozen boven letter-klankkoppelingen.

In onze laatste studie besteden wij aandacht aan het zogenaamde letterpositie-effect dat optreedt als gevolg van het feit dat in Urdu veel letters van vorm veranderen afhankelijk van de plaats die ze in een woord innemen. Beide groepen, maar vooral de zwakke lezers, lazen woorden waarin de letters van vorm veranderden beter dan cognaten waarin de letters niet van vorm veranderden na verplaatsing.

Met deze op de DRM gebaseerde testbatterij zijn we in staat diagnostische profielen van leesvaardigheid van goede en zwakke lezers op te stellen.

About the Author

Sana-e-Zehra Haidry was born on October 26, 1978 in Karachi, Pakistan. She holds three Masters' degrees, i.e. in psychology, public health and clinical linguistics, with a special focus on dyslexia, from various reputable international universities. She earned her Master's in Psychology from the University of Karachi where she ranked second in the psychology department and third in the faculty with her work. Her Master's in Public Health with specialization in International Mental Health was obtained from the University of Melbourne on an Australian Development Scholarship (ADS-AUSAID), where her research protocol entitled 'How to identify the needs of mental health professionals in Pakistan in order for them to contribute effectively to mental health reforms' earned her a first class honours (H1) degree. She was subsequently admitted to the European Master's programme in Clinical Linguistics (EMCL), which is part of the Erasmus Mundus Programme. She received training in Potsdam (DE) and Groningen (NL). In 2013 she acquired her MSc degree with the overall classification 'excellent' for her thesis 'Developing a screening checklist for children of ages 5-11 years in Karachi Pakistan'. Later in 2013, she was admitted to the joint Erasmus Mundus PhD Programme International Doctorate for Experimental Approaches to Language And Brain (IDEALAB) of the Universities of Groningen (NL), Newcastle (UK), Potsdam (DE) Trento (IT), and Macquarie University (AU). She conducted her research 'the assessment of dyslexia in the Urdu Language' at the Universities of Groningen and Macquarie and fulfilled her internship at the university of Newcastle. She also has ample experience in conducting training courses for teachers and parents in the Urdu and English languages with a particular focus on reading and spelling issues. She has worked as a research consultant, head of a training unit and chief coordinator in the Learning Differences Project. Her research publication and presentations are mostly on the topics of learning, emotional and behavioural problems in children and the assessment of dyslexia in Urdu and English.

Over de Auteur

Sana-e-Zehra Haidry is op 26 oktober 1978 in Karachi, Pakistan geboren. Ze is in het bezit van drie masterdiploma's, te weten in Psychologie, Volksgezondheid en Klinische Linguïstiek, in het bijzonder dyslexie, die ze verwierf aan verschillende internationale, gerenommeerde universiteiten. Ze behaalde haar masters in Psychologie aan de Universiteit van Karachi waar ze in haar afstudeerjaar met haar werk een tweede plaats bij de vakgroep Psychologie en een derde plaats bij de faculteit innam. Haar masters in Volksgezondheid met de specialisatie Internationale Geestelijke Gezondheidszorg verkreeg ze aan de Universiteit van Melbourne waar haar onderzoek financieel werd ondersteund door een 'Australian Development Scholarship' (ADS-AUSAID) en haar onderzoeksprotocol getiteld 'How to identify the needs of mental health professionals in Pakistan in order for them to contribute effectively to mental health reforms' beloond werd met het judicium cum laude (first class honours degree). Ze werd vervolgens toegelaten tot het European Master's Programme in Clinical Linguistics (EMCL) dat onderdeel uitmaakt van het Erasmus Mundus programma. In dit kader werd ze zowel in Potsdam (DE) als in Groningen (NL) opgeleid. In 2013 ontving ze haar MSc, waarbij haar masterthesis 'Developing a screening checklist for children of ages 5-11 years in Karachi Pakistan' de kwalificatie 'excellent' kreeg. Later dat jaar werd ze toegelaten tot het gezamenlijke

Erasmus Mundus PhD Programma ‘International Doctorate for Experimental Approaches to Language And Brain’ (IDEALAB) verzorgd door de Rijksuniversiteit Groningen (NL), Newcastle University (UK), Universität Potsdam (DE), Università di Trento (IT), and Macquarie University (AU). Haar PhD-onderzoek getiteld ‘The assessment of dyslexia in the Urdu Language’ voerde ze uit op de universiteiten van Groningen en Macquarie en ze liep stage aan de universiteit van Newcastle. Daarnaast heeft ze ruime ervaring in het verzorgen van trainingscursussen in Urdu en Engels, met bijzondere aandacht voor lees- en spellingproblemen, voor leerkrachten en ouders. Ze is werkzaam als onderzoeksconsulent, hoofd opleiding/training en coördinator van het ‘Learning Differences Project’. Haar wetenschappelijke publicaties en presentaties zijn voornamelijk op het gebied van leren, emotionele en gedragsproblemen bij kinderen en de diagnostiek van dyslexie in kinderen die zowel Urdu als Engels spreken.

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