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Predictors of Reading in Urdu: Does Deep Orthography Have an Impact?

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The aim of this study was to establish the extent to which rapid automatized naming (RAN) and non-word repetition (NWR) tasks predict reading fluency and reading accuracy in Urdu. One hundred sixty (8–9 years) children attending two types of schools (Urdu and English medium schools) were distributed into two groups, a control and a reading disability group on the basis of teacher's report. The results confirmed the role of RAN in predicting reading fluency in both groups. The role of NWR as a predictor of accuracy was also confirmed, although the strength of the relationship was modulated by RAN in the reading disability group. There are no tests available to identify children with reading problems in Urdu. Our study supports the validity of NWR and RAN tasks for the purposes of screening for reading deficits. The performance results also confirm the original grouping based on teacher reports. The study further highlights the importance of medium of instruction and increased oral language input in learning to read. © 2014 The Authors. *Dyslexia* published by John Wiley & Sons Ltd.

Keywords: phonological deficit; non-word repetition; fluency; accuracy; naming speed; reading difficulties

Key Messages

- Reliability of teacher reports in screening for reading difficulties in the classroom.
- Appropriateness of non-word repetition and rapid automatized naming tasks for establishing reading problems in Urdu.
- School type and exposure to instruction influences reading skills.

While the predictors of reading performance in all alphabetic languages (studied so far) have been found to be relatively universal, the strength of the relationship can vary on the basis of script transparency (e.g. Caravolas et al., 2012; Vaessen, Bertrand, Tóth, Csépe, & Faísca, 2010; Ziegler et al., 2010). In this study, we tested for the first time to what extent the depth of Urdu orthography impacts on reading performance in children aged 8–9 years, and whether tasks, such as non-word repetition (NWR) and rapid automatized naming (RAN), can tap reading skills in that age group, both for typical readers and children with a reading deficit (RD).

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Urdu has an opaque and complex orthographic system. It is spoken worldwide (Schmidt, 2003) by a large number of people, yet it is underdescribed. Some characteristics of Urdu, which make it difficult to read, are the absence of vowel letters and the omission of diacritics in its script (Rao, Vaid, Srinivasan, & Chen, 2010). Furthermore, the Urdu graphemic system is cursive in nature (Mirdehghan, 2010) and characterized by many to one mappings between graphic symbols and sound (Rao et al., 2010). Although Urdu has vowel letter and diacritic omissions, very much like Hebrew, there are differences, and its cursive property makes it more difficult to read.

The Pakistani literacy situation is characterized by multilingualism, in that, whereas Urdu is the national standard language, most readers have another first language. The children who participated in this study are representative of this situation. The first language of the children is Punjabi, but when they enter school and start formal literacy instruction, they have to confront two new languages, Urdu and English, both with opaque, but completely different orthographies and using different alphabetic systems. Whereas for the majority of the students, both of these languages are new; for some of them (those from high socio-economic status families), Urdu might be another L1, in addition to Punjabi. Punjabi is rarely written or taught in schools (whether as a medium of instruction or as a subject) until graduate level[1].

We used a battery of tasks documented in recent research to predict reading performance (e.g. Kirby, Parrila, & Pfeiffer, 2003). Such tasks have also been found suitable for screening for RDs (dyslexia) (e.g. Adams, 1990; Cutting & Denkla, 2001; National Reading Panel, 2000; Wimmer, Mayringer, & Landerl, 2000; Wolf, Bowers, & Biddle, 2000). The first task was NWR, and the second task comprised the four standard subtests used to test RAN, colour naming, object naming, digit naming and letter naming.

Phonological measures and RAN, as a measure of naming speed, have been reported to predict contrasting aspects of reading (e.g. Bowers, 1993; Spring & Davis, 1988; Young & Bowers, 1995). RAN is more closely associated with reading fluency; whereas phonological measures are linked to accuracy and comprehension. In addition, there is evidence of a predictive role of RAN in reading accuracy, as well as reading fluency (e.g. Savage & Frederickson, 2005). The strength of prediction of phonological tasks and RAN tasks has also been shown to vary in regard to the depth of language orthography (Vaessen et al., 2010).

NON-WORD REPETITION

Non-word repetition has traditionally been used as a measure of phonological working memory (Gathercole & Baddeley, 1989).

Yet it also has a tradition in reading research as a component in phonological assessment batteries (Savage & Frederickson, 2005; Ziegler et al., 2010), as well as a proven history of a powerful tool, which taps phonological processing in both transparent and non-transparent orthographies (Paulesu et al., 2001). The role of NWR as a measure of phonological processing has been confirmed in recent studies (e.g. Bowey, 1996; de Bree, Wijnen, & Gerrits, 2010). In the study by Stone and Brady (1995), performance on the NWR task was the individual variable most strongly associated with measures of reading performance. Moreover, it has been shown that phonological processing, measured by NWR, is a core problem for dyslexic individuals in both opaque (English) and transparent (Italian) languages (Paulesu et al., 2001).

By virtue of its nature, NWR involves a number of competencies, such as memory for auditory material, and phonological awareness (Brady, 2011; Coady & Evans, 2008). NWR strongly relies on phonological awareness, because it requires for the string heard to be matched to the phonological system of the language tested and to be identified as a proper phonological object in that language. The role of working memory is to store the string temporarily, both for the purposes of identification (decoding) and for subsequent encoding for repetition. Indeed, NWR shows an association both with phonological awareness and phonological memory in factor analysis, which might, in turn, suggest a single underlying process (Snowling, Chiat, & Hulme, 1991). Furthermore, failure on NWR can indicate problems in phonological segmentation, phonological perception and phonological short-term memory (Brady, Shankweiler, & Mann, 1983; Gathercole, 1995; Snowling, 1981), all of which are basic phonological competencies.

Crucially, the processes involved in a NWR task tap the participant's phonological competence, such as the ability to decode and encode phonological information. It has been suggested that the ability to encode phonological representations may be the single underlying mechanism causing reading problems in poor readers (Brady, 2011). In this study, we are using NWR as a measure of underlying phonological encoding ability and as a tool that taps (the quality of) phonological representations. There is convincing evidence in research on reading that NWR alone can be used as a good, reliable and efficient tool for phonological measures (Bishop, North, & Donlan, 1996; de Bree et al., 2010; Conti-Ramsden, Botting, & Faragher, 2001; Dollaghan & Campbell, 1998; Weismer et al., 2000).

A limitation of the current study is that we did not use typical phonological awareness tasks (e.g. a rhyming task or a phonemic manipulation task). The main reason for this is the dependence of sound manipulation skills on orthography. In view of the specific orthographic nature of Urdu (detail in the next section), we suspected that such tasks were not suitable for Urdu. In reading research, explicit phonological abilities have not always been good predictors of reading development for certain languages. Consistent with the grain size hypothesis of reading (Ziegler & Goswami, 2006), missing phonemic information (vowels) in the Urdu script prevents sound manipulations at the phonemic level. Frost (2006) suggests that in Hebrew, which presents similar problems, the valid level of manipulation is the syllable (consonant-vowel strings). Indeed, in the second stage of the project reported here, we tested a subgroup of the original participants, one control group ($N = 32$) and one RD group ($N = 34$) on a battery of phonemic awareness tasks, including phoneme substitution, phoneme deletion and rhyme oddity. No significant differences were found between the two groups on any of these tasks (Farukh & Vulchanova, in press).

It has been documented that children with dyslexia often face difficulties with NWR (Goulandris, Snowling, & Walker, 2000; Snowling, 1981). In a recent study, de Bree *et al.* (2010) reported a correlation between NWR abilities and literacy skills in children at risk for dyslexia. Yet the strength of the relationship between NWR scores and reading performance has varied across studies. Whereas some studies document only small differences between controls and dyslexic groups on NWR tasks (Boada & Pennington, 2006; Landerl, 2001), others have reported significant differences (Marshall, Snowling, & Bailey, 2001; Mauer & Kamhi, 1996). This makes further testing on this task even more compelling.

RAPID AUTOMATIZED NAMING

The second task we selected for this study was RAN. There are several studies that confirm a relationship between RAN and easy text reading and text reading speed (e.g. Bowers, 1993; Huff, Sorenson, & Dancer, 2002; Savage & Frederickson, 2005; Wolf, 1986; Young & Bowers, 1995). It has been claimed that RAN, and in particular, the RAN alphanumeric component (digit naming and letter naming), is associated with reading success (e.g. Wolf et al., 2000, 2002). RAN has been found to be a longitudinal independent predictor of early literacy development not only in English but also in languages with more consistent orthographies such as Spanish, Czech and Slovak (Caravolas et al., 2012). Although it has a proven history as the most powerful diagnostic pointer of later reading skills in regular orthographies (Wolf & Denckla, 2005), such as German (Landerl & Wimmer, 2000), Dutch (van den Bos, Zijlstra, & lutje Spelberg, 2002) and Finnish (Holopainen, Ahonen, & Lyytinen, 2001), it is an equally powerful predictor of reading in languages with different demands (Wolf & Denckla, 2005), like Hebrew (Breznitz, 2001), and in monosyllabic Chinese orthography (Ho, Chan, Tsang, & Lee, 2002).

As a predictor of reading competence, RAN has a long and controversial history. It has been suggested that there is a relationship between reading and RAN, because they share a requirement of rapid execution (Kail, Hall, & Caskey, 1999). Another predominant and fairly controversial view is that reading and RAN could be linked through the more general phonological processing system (Torgesen, Wagner, & Rashotte, 1994; Wagner & Torgesen, 1987), because both tap the speed of accessing phonological representations in long-term memory (Wagner & Torgesen, 1987; Wimmer et al., 2000). Thus, RAN might measure automaticity in accessing phonological representations. Alternatively, RAN can reflect the efficiency of matching visual information to phonological codes (Vaessen, Gerretsen, & Blomert, 2009), suggesting that there is a phonological component to rapid naming, which in turn may account for a portion of its variance with reading. A brain imaging study of dyslexic adults (McCrory, Mechelli, Frith, & Price, 2005) found a common pattern of neural activation for reading and object naming tasks. This may be evidence that both processes rely on a common general core mechanism that supports the integration of visual, phonological and semantic information.

Contrary to such views, some studies suggest that RAN is independent of phonological processing and can account for variance in reading independently of phonological measures (cf. discussion in Georgiou, Parrila, & Kirby, 2009). This view implies that a naming deficit is directly related to orthographic processing. If letters are recognized at a slower rate, letter representations of words are not activated sufficiently fast to create sensitivity to common orthographic patterns, resulting in delayed (slow) and problematic reading (Bowers, Golden, Kennedy, & Young, 1994; Bowers & Newby-Clark, 2002).

Yet, despite these controversial accounts, there is significant evidence confirming the relationship between RAN and reading, both concurrently and longitudinally (e.g. Caravolas et al., 2012; Lervåg, Bråten, & Hulme, 2009; Savage & Frederickson, 2005). Also, it has been shown that the relationship between RAN and reading fluency increases with age and experience, as a single reading network for all types of words gets established (Vaessen & Blomert, 2010).

The four RAN subtests have been shown to differ in their predictive role at different stages in the process of learning to read. In the initial stages, non-alphanumeric RAN (objects and colours) acts as a long-term predictor of reading, and this may relate to the efficacy of a (more general) learning mechanism involved in the process of learning to read. However, later in development, the role of non-alphanumeric RAN diminishes, whereas that of alphanumeric RAN (digits and letters) increases, becoming the sole predictor of reading at this stage (e.g. Lervåg et al., 2009; Savage & Frederickson, 2005).

From the point of view of screening for reading disability, there is sufficient evidence that dyslexic children are significantly slower than age-matched and reading-matched controls on RAN tasks (e.g. Araújo et al, 2011). It has been suggested that this poor performance among dyslexic readers is not due to less reading experience or limited letter names knowledge but to unsuccessful automatizing of rapid naming skills (e.g. Wolf & Bowers, 1999). More importantly, the naming speed deficit found in dyslexia appears to be more pronounced than the phonological deficit, and this applies both in transparent orthographies, for example, Spanish, Finnish and German, and in entirely different and diverse orthographies, such as Hebrew, Chinese and Japanese (as discussed in O'Brien, Wolf, & Lovett, 2012; Wolf & Denckla, 2005).

Whereas some studies use a single measure of rapid naming, commonly digit naming (e.g. Levy, Abello, & Lyschynchuk, 1997; Young & Bowers, 1995), others typically use two RAN measures, one from each subcategory, for example, digit naming and object naming (e.g. Savage & Frederickson, 2005). In the absence of any documented results of RAN as a predictor of Urdu reading, we ran the full RAN battery.

URDU

It has been claimed that the cognitive development related to the acquisition of reading skills is universal in all languages, but the degree of orthographic depth of the reading system might impede or promote it. Because the same cognitive components are involved in the development of fluent reading skills in transparent and opaque orthographies (Vaessen et al., 2010), orthography becomes an important mediator.

Urdu has a complex orthography. It has an alphabetic script borrowed from Arabic and Persian, with additional letters for the sounds, which are not found in Arabic and Persian. Its cursive, multilevel form is called Nastaliq (Naim, 1999; McGregor, 1992 in Schmidt, 2003) and comprises 38 letters. Two of the three proper vowel letters also represent semivowels. All other vowels are represented by diacritics positioned above or below the preceding letter. However, typical Urdu writing omits most of the diacritics leaving only consonants behind (Rao et al., 2010). The reader has to provide the missing vowel information. Quite often, the omission of diacritics may lead to homographs, and successful word identification can only proceed with contextual help.

A further graphemic problem is that the same letters are written differently in different positions within the word. From the point of view of the visual identification of letters, Urdu presents a further problem, known as its cursive property: many graphemes look similar or even identical and can only be discriminated by the presence of, the number of or positioning of, dots (Mirdehghan, 2010).

Compared with English, Urdu orthography is 'deep' and challenging in a very different way, in that it gives rise to ambiguity. When vowels are present in the form of diacritics, Urdu appears to be shallow, as sometimes suggested (Mumtaz & Humphreys, 2001). Yet, when vowel information is missing, as is the case in all adult materials, as well as children's reading books from grade 2 onwards, word identification relies on sounding the word out and on contextual help.

Similar to English, Urdu orthography is not consistent and characterized by many to one mappings between letter symbols and sound (Rao et al., 2010). Furthermore, compared with European languages (e.g. Norwegian and English), Urdu has a richer and complex sound system with 44 consonants, eight long oral vowels, seven long nasal vowels, three short vowels and numerous diphthongs (Hussain, 2004; Saleem et al., 2002).

Most research on the correlates and predictors of reading has had a focus on (relatively) transparent alphabetic orthographies, for example, Norwegian (e.g. Lervåg et al., 2009; Lervåg & Hulme, 2009) and German (e.g. Wimmer, Mayringer, & Landerl, 1998) or the type of deep orthography instantiated in English (Warmington & Hulme, 2011). Relatively few studies have investigated reading and reading related skills in children cross-linguistically (e.g. Frith, Wimmer, & Landerl, 1998; Patel, Snowling, & de Jong, 2004; Wimmer & Goswami, 1994). Yet, there is variation in the relative importance of the factors found to predict reading skills across languages, which makes language comparisons compelling (Caravolas et al., 2012). Urdu is an example of a widely spoken language, which has hardly been investigated in this respect.

In view of the nature of Urdu orthography, this study tries to investigate the reliability of the relationship between NWR and RAN tasks, and reading (at grade 3) in both typical and atypical readers, and to establish whether tasks used in more transparent languages are appropriate in predicting reading skills in Urdu as well. Reading outcomes, fluency and accuracy have been used as reading measures in the present analysis.

PREDICTIONS

In this study, we had the following predictions:

We expected both phonological and RAN skills as concurrent predictors of reading performance in Urdu. Furthermore, we expected these predictors to correlate with different aspects of reading performance. Assuming that RAN taps the ability to match visual/orthographic information to phonological codes, and in view of the inconsistent and deep nature of Urdu orthography, we expected alphanumeric RAN to predict not only fluency but also accuracy, whereas NWR was expected to predict reading accuracy (Felton & Brown, 1990; Nicholson & Fawcett, 1994; Savage & Frederickson, 2005). We expected further the predictive role of RAN in reading performance to be stronger in impaired readers than in controls (Araújo et al., 2011). Secondly, we expected there to be a considerable difference in performance on both NWR and RAN tasks between controls and the children in the reading disability group.

An open question to explore in our results was whether RAN and NWR independently predicted reading skills or not in our sample.

Thirdly, given the difference in curricula in the two types of schools, resulting in different amounts of exposure to the two languages of instruction (Urdu and English), we set out to test the effect of quantity of exposure to Urdu (the second language for many of the children in the sample) in learning to read Urdu, in both the control and the reading disability groups. We expected that the Urdu school language environment, where the children are exposed primarily to Urdu, will have a positive influence on both reading fluency and accuracy in Urdu for both typical and poor readers. In contrast, for the same groups in English medium schools, the reverse pattern (better literacy skills in English but not Urdu), was observed (Farukh & Vulchanova, in press).

MATERIAL AND METHOD

Participants

Participants in the present study were 160 third graders (96 boys and 54 girls) of the same age group ranging between 8 and 9 years[2] at both Urdu and English medium schools. The selected schools were situated in a developing district of Punjab. The schools were attended by children from all social classes and could be considered as representative of the whole population in the district. The participants came both from the city and the peripheral villages. Punjabi is the first language of the children; however, it is rarely used in a written form. Urdu is the national language, the language of the media, the medium of instruction at schools and another first language for some of the children (depending on the social class) in that area. English is the second language and is the medium of instruction for higher levels of studies in Pakistan. English is also the medium of instruction at a few private sector schools; these schools have English as their medium of instruction in all subjects (using Content and Language Integrated Learning). Most children attending those schools come from families with high socio-economic status. In these schools, Urdu is taught as one of the subjects, as is the case of English in Urdu medium schools.

In all Pakistani schools, English is taught and evaluated as a compulsory subject from grade 1. In Urdu medium schools (both public and private), all subjects are taught in Urdu, and English is taught as a subject; though in middle and secondary level classes, English occupies the maximum time on the time-table, because it is taught as two subjects, English literature and English grammar. Contrary to this pattern, in English medium schools, all subjects are taught in English, whereas Urdu is taught as one subject. Communication in class can be both in Urdu and English, whereas out of class, it is primarily in Urdu.

The children in the present study came from four English medium and four Urdu medium schools and were all in the third grade. They were distributed into two groups in each school on the basis of teachers' reports: one group included the children with reading and writing problems (reading disability group), whereas the other included the children with typically developing reading and writing skills (control group).

None of the children from the reading disability group could be said to suffer from dyslexia with certainty, because there is no test battery available for screening children with dyslexia in Pakistani public or private sector schools. But the problems we have observed and those reported by the teachers are highly similar to those of developmental dyslexia. For this reason, this group will be referred to as the 'reading disability group' in this paper.

We have analysed the data by group in two different ways. For the purposes of the multiple regressions and factor analysis, we analyse the participants in two main groups by status (control group ($N = 71$) and RD group ($N = 79$)). This is dictated by the main purpose of our study to investigate the role of NWR and rapid naming in predicting reading skills in both typical and atypical readers. In order to investigate the effect of the two independent factors, reading status and medium of instruction, we conducted the analyses on all participants ($N = 150$), with reading status and medium of instruction as independent variables. The RD group from Urdu medium schools originally comprised 48 children; however, 10 participants were dropped from the statistical analyses because they were unable to read at all, leaving us with 38 children for statistical analysis where a reading score was required.

Preliminary Procedure

Prior to the actual testing, the language teachers of grade 3 were interviewed and asked to point out the children in their class with reading, writing and spelling problems in Urdu and English. The grouping was based on the teachers' reports. The students, reported to have reading and writing problems, made up the reading disability group. During the interviews, the teachers also informed that some of the children had problems in differentiating the small letters of English, which are mirror images of each other such as *b* and *d*, and *p* and *q*. Although this problem was reported to be overcome by the children at the time of testing, the children were still facing difficulties with reading.

At the same time, the teachers were asked to identify the same number of children who did not appear to have reading or writing problems and had typically developing reading and writing skills. These children made up the control group. The same interviewing procedure was repeated in four Urdu medium and four English medium schools. The children were not tested on or controlled for any verbal or non-verbal IQ measures because of the absence of standardized IQ tests in Urdu at the time of testing.

Tasks and Testing Procedure

The first task was a NWR task. The items used were constructed specifically for the study following the rules of Urdu phonology and orthography. The NWR task comprised repetition of one-syllable, two-syllable, three-syllable and four-syllable non-words lists, each consisting of 10 words. Consistent with previous findings (Gathercole, 1995; Snowling, 1981) that longer words tend to be harder to repeat accurately, and in the absence of significant differences in performance observed between typical and poor readers with shorter words, only the results from the four-syllable non-word-list were used in our analysis. Performance on this task was measured by the number of wrongly repeated non-words.

The second task in the testing was a classical RAN battery, based on a standardized version of the test (Wolf & Denckla, 2005) with four subtasks: letter naming, digit naming, object naming and colour naming. All four test-sets included five items distributed repeatedly and randomly in five rows (APPENDIX A). The letter set was created by using frequent letters from the Urdu orthography, which were randomly presented on a printed A3 size sheet. Performance on RAN tasks was measured by the total naming time.

Reading skills (fluency and accuracy) were assessed on reading an easy short Urdu text (a total of 74 words). To ensure that the children were familiar with all words in the text, we consulted their textbooks. Because diacritics are systematically omitted in texts in school textbooks already from grade 2 on, the words in the test text were entered without diacritics.

RESULTS

The reading measures used in the analyses as dependent variables were reading fluency and reading accuracy. Reading fluency is the number of all words read per second, and reading accuracy is the percentage of words read correctly (Howell, Fox, & Morehead, 1993).

The descriptive statistics (Table 1) for fluency and accuracy of reading the short Urdu text revealed that the children from both groups in our sample performed adequately and in compliance with the international standards for reading fluency and accuracy for the respective groups for grade 3 (except for accuracy in the reading disability group) (Howell et al., 1993).

For all tables, RAN colours is equal to the time taken (in seconds) for naming colours, RAN objects is equal to the time taken (in seconds) for naming objects, RAN letters is equal to the time taken (in seconds) for naming letters, RAN digits is equal to the time taken (in seconds) for naming digits and NWR is equal to the errors made in repeating non-words.

The frequency distribution curves of reading fluency and accuracy were plotted for both groups. For fluency, the distribution curve showed almost normal distribution for controls with a skewness value of +.46. The curve for the RD group (skewness value of +.5) did not require any transformation of the data either. For accuracy, the frequency distribution curves of both groups were negatively skewed. Before proceeding with further analyses, the data for accuracy were transformed, by

Table 1. Descriptive statistics showing mean scores of children in the control group and the reading disability group of both types of schools

		Control group		Reading disability group	
Variables	School type	Mean	Standard deviation	Mean	Standard deviation
Fluency	Urdu	2.61	.76	1.72	.68
	English	1.88	.63	1.29	.67
Accuracy	Urdu	98.19	3.13	94.28	6.33
	English	98.03	2.73	93.51	6.04
NWR	Urdu	2.13	1.82	3.92	1.93
	English	1.64	1.58	2.53	2.11
RAN letters	Urdu	35.10	6.61	44.29	11.28
	English	41.12	10.18	47.13	13.11
RAN digits	Urdu	24.23	4.13	28.74	5.45
	English	24.61	4.47	29.14	6.74
RAN objects	Urdu	43.49	7.32	53.31	11.39
	English	44.26	6.36	50.75	14.85
RAN colours	Urdu	53.95	10.66	68.77	17.41
	English	52.95	12.39	57.75	14.58

Note: Control group (Urdu) $N = 38$, control group (English) $N = 33$.
Reading disability group (Urdu) $N = 39$, reading disability group (English) $N = 40$.
NWR, non-word repetition; RAN, rapid automatized naming.

using Log. The transformation was successful and reduced the skewness from −2.13 to .76 for the control and from −1.77 to −.31 for the RD group.

To assess our first hypothesis concerning the concurrent predictors of reading in Urdu, a hierarchical regression analysis was performed. To ensure that only variables that correlated highly with each of the dependent variables were included in the analysis, prior to the hierarchical regression, we ran a Pearson's correlation analysis (Tables 2 and 3) by splitting the files into reading disability and control group.

In the hierarchical regression analysis, the variables were entered one by one, and the contribution of every variable was calculated by controlling the effect of the other variables. Both fluency and accuracy were used as dependent variables in separate analyses, and the analyses were performed by splitting the file into two to get separate tables for both the control and the reading disability group. In the analyses for fluency, the variables were entered in two steps. RAN objects was entered at the first step, whereas RAN digits and RAN letters were entered alternatively at the second step, after entering RAN objects and controlling for its effect.

For both groups, both RAN letters and RAN digits significantly predicted fluency when entered at step 2 alternatively (Table 4). RAN letters was a stronger predictor of fluency, whereas RAN digits was the second significant predictor of fluency.

For reading accuracy, the variables were also entered in two steps. NWR was entered at the first step, whereas RAN letters was entered at the second step after entering NWR and controlling for its effect (Table 5).

Table 2. Summary of intercorrelations for scores on all variables for the control group

Variables	1	2	3	4	5	6	7
Fluency		−.53**	−.23	−.54**	−.37**	−.02	−.14
Accuracy			.35**	.20	.20	−.08	.04
NWR				−.09	.26*	.62	.19
RAN (letters)					.45**	.27*	.29*
RAN (digits)						.027**	.32**
RAN (objects)							.60**
RAN (colours)							

*Correlation is significant at the 0.05 level (two-tailed).
**Correlation is significant at the 0.01 level (two-tailed).
NWR, non-word repetition; RAN, rapid automatized naming.

Table 3. Summary of intercorrelations for scores on all variables for the reading disability group

Variables	1	2	3	4	5	6	7
Fluency		−.62**	−.04	−.58**	−.50**	−.26*	.14
Accuracy			.18	.32**	.12	−.08	.04
NWR				.06*	−.05	−.05	.19
RAN (letters)					.51**	.43**	.29*
RAN (digits)						.47**	.32**
RAN (objects)							.60**
RAN (colours)							

*Correlation is significant at the 0.05 level (two-tailed).
**Correlation is significant at the 0.01 level (two-tailed).
NWR, non-word repetition; RAN, rapid automatized naming.

Table 4. Hierarchical regression analysis exploring predictors of reading fluency in the control group and the reading disability group

		Control group		Reading disability group	
Step	Variables	Beta	$R^2/\Delta R^2$	Beta	$R^2/\Delta R^2$
1	RAN (objects)	−.02	.000	−.26*	.07*
2	RAN (objects)	.09		−.04	
	RAN (digits)	−.40***	−.15**	−.48***	.25***
2	RAN (objects)	.14		−.01	
	RAN (letters)	−.57***	.31***	−.57***	.33***

*$p < .05$. **$p < .01$. ***$p < .001$. Beta = standardized coefficients beta; RAN, rapid automatized naming.

Table 5. Hierarchical regression analysis exploring predictors of reading accuracy in the control group and the reading disability group

		Control group		Reading disability group	
Step	Variables	Beta	$R^2/\Delta R^2$	Beta	$R^2/\Delta R^2$
1	NWR	.35**	.12**	.18	.03
2	NWR	.37***		.20	
	RAN (letters)	.23*	.17***	.33**	.14**

*$p < .05$. **$p < .01$. ***$p < .001$. Beta = standardized coefficients beta; NWR, non-word repetition; RAN, rapid automatized naming.

For the control group, NWR was the most significant predictor of accuracy, whereas RAN letters was the other significant predictor of accuracy at step 2. In contrast, in the reading disability group, RAN letters was the only predictor of accuracy.

To further explore the relationship among the variables, a principal component analysis was conducted with varimax rotation, for both groups (control group *Kaiser-Meyer-Olkin* measure of sampling adequacy (KMO) = 0.59, Barlett's test of sphericity χ^2 (15) = 91.59, $p < .001$; RD group KMO = 0.7, Barlett's test of sphericity χ^2 (15) = 125.95, $p < .001$).

All the variables were let to load on factors without specifying the number of factors, resulting in loading on three factors for the control group (Table 6). The first factor (reading and naming factor) included both reading measures (fluency and accuracy), letter naming and digit naming. This factor reflects the dependence of reading skills on automatized access of phonological representations. The second factor (automaticity factor) included only automaticity measures: letter naming, digit naming and object naming. The third factor (accuracy and phonological factor) included NWR and accuracy and clearly reflects the interdependence between accuracy and NWR.

For the reading disability group, the variables loaded on two factors. One of the factors can be named the 'fluency and naming factor', as it included only reading fluency and naming measures. The other factor can be labelled the 'reading and phonological factor', as it includes both reading measures and NWR.

In order to test the second and third hypotheses, a two-way MANOVA was run to investigate the effects of reading group (control or reading disability group) and the medium of instruction (Urdu or English) on all dependent variables. It revealed a significant main effect of reading group on performance on all tasks (F (6, 141) = 12.82, $p < .001$, Wilks'Λ = .65, $\eta_p^2 = .35$), thus confirming our original

Table 6. Summary of factor Loadings for the control group and the reading disability group with Varimax rotation of reading measures, non-word repetition, and rapid automatized naming tasks

	Factors for control group			Factors for reading disability group	
Item	Reading and naming	Automaticity	Accuracy and phonological	Fluency and naming	Reading and phonological
Fluency	**-.88**	−.04	−.15	**−.67**	**−.60**
Accuracy	**.67**	−.23	**.48**	.22	**.88**
NWR	.08	.14	**.93**	−.20	**.51**
RAN (letters)	**.74**	**.44**	−.34	**.80**	.21
RAN (digits)	**.46**	**.61**	.22	**.81**	−.02
RAN (objects)	−.08	**.88**	.01	**.74**	−.31
Eigenvalues	1.98	1.40	1.28	2.40	1.53
Percentage of variance	33.05	23.25	21.30	39.92	25.51
α	.28	.55	.24	.57	−.05

Note: Factor loadings >.40 are in boldface.
NWR, non-word repetition; RAN, rapid automatized naming.

hypothesis. The between-subject effects were as follows: for fluency, $F = 42.60$, degrees of freedom (d.f.) = 1, $p < .001$, $\eta_p^2 = .23$; for accuracy, $F = 41.65$, d.f. = 1, $p < .001$, $\eta_p^2 = .23$; for NWR, $F = 18.92$, d.f. = 1, $p < .001$, $\eta_p^2 = .12$; for RAN letters, $F = 19.11$, d.f. = 1, $p < .001$, $\eta_p^2 = .12$; for RAN digits, $F = 24.81$, d.f. = 1, $p < .001$, $\eta_p^2 = .15$; and for RAN objects, $F = 21.57$, d.f. = 1, $p < .001$, $\eta_p^2 = .13$.

There was also a significant main effect of medium of instruction for all tasks (F (6,141) = 10.03, $p < .001$, Wilks'$\Lambda = .70$, $\eta_p^2 = .30$), suggesting that oral language of instruction impacts on reading skills. This effect was largely due to an effect of fluency ($F = 26.81$, d.f. = 1, $p < .001$, $\eta_p^2 = .16$) but not accuracy ($F = .2.17$, d.f. = 1, $p = .14$, $\eta_p^2 = .02$). The effects for the NWR and RAN tasks were as follows: for NWR, $F = 9.44$, d.f. = 1, $p = .003$, $\eta_p^2 = .06$; for RAN letters, $F = 6.49$, d.f. = 1, $p = .01$, $\eta_p^2 = .04$; for RAN digits, $F = .03$, d.f. = 1, $p = .86$, $\eta_p^2 = .00$; and for RAN objects, $F = .26$, d.f. = 1, $p = .61$, $\eta_p^2 = .002$.

DISCUSSION

The results from the hierarchical regression analysis confirm our first prediction. Performance on both RAN letters and RAN digits predict reading fluency both for controls and for the reading disability group. For reading accuracy, we find a difference between controls and the reading disability group. In the control group, both NWR and RAN letters are significant concurrent predictors of reading accuracy. However, only performance on RAN letters predicts reading accuracy in the reading disability group but not NWR. Thus, our results underscore the role of alphanumeric RAN in predicting reading fluency both in typical readers and in children with reading problems. Further, we find confirmation of the role of NWR as a predictor of accuracy only in typical readers but not in the reading disability group (Araújo et al., 2011; Felton & Brown, 1990; Savage & Frederickson, 2005).

Our results also support earlier findings of the predictive power of alphanumeric RAN for accuracy (e.g. Blachman, 1984). Previous research on other languages (Lervåg et al., 2009; Manis, Doi, & Bhadha, 2000; Savage & Frederickson, 2005) suggests that performance on non-alphanumeric RAN no longer plays a role in predicting reading at this stage. However, the results of the RD group suggest that performance on non-alphanumeric RAN (RAN objects) may still exert a role on reading performance at early stages of reading acquisition in deep orthographies, such as Urdu, and specifically in the context of a RD, most probably implying delayed reading development.

The finding that speed of automatized naming is a strong predictor of reading accuracy (and not only of reading fluency) in both groups favours the hypothesis that RAN and reading both rely on the same neural networks (Clarke, Hulme, & Snowling, 2005; Manis, Seidenberg, & Doi, 1999; McCrory et al., 2005). A possible explanation could be that RAN correlates with reading skills, because it taps the ability to set up arbitrary associations between (visual) graphic symbols and their labels. Therefore, it may be crucial in predicting reading skills in exception words and in opaque orthographies. This view is consistent with the highly non-transparent (cursive) nature of Urdu orthography and is further confirmed by our results, whereby alphanumeric RAN predicts both fluency and accuracy in both controls (albeit to a limited degree) and the reading disability group. Such results provide support for the predictions of the orthographic depth hypothesis (Katz & Frost, 1992), where word recognition in deep orthographies depends more strongly on the visual orthographic shape of words rather than on grapheme-phoneme decoding. In such orthographies, phonological decoding skills are expected to play a lesser role, as reflected in the current results.

In the principal component analysis, for controls, all variables are loaded on three factors: a *reading and naming* factor, an *automaticity* factor and an *accuracy and phonological* factor. The first factor included fluency, accuracy, RAN letters and RAN digits; the second included only naming speed measures; and the third factor included accuracy and NWR. The loading of RAN letters and digits together with both fluency and accuracy on the same factor underscores the strong association of RAN with the two basic components of reading and further suggests that reading skills depend on the rapid automatized access of phonological patterns. The first, second and third factors, respectively, accounted for 33.05% (reading and naming), 23.25% (automaticity) and 21.30% (accuracy and phonological) of the variance in the control group. More importantly, this pattern of loading could be seen only in the control group.

At the same time, in the reading disability group, the two factors, *fluency and naming* factor, and *reading and phonological* factor, accounted for 39.92%, and 25.51%, respectively. These results indicate a greater contribution of the reading (fluency) and the naming factor in explaining the variance in the reading disability group. The results are consistent with previous research (e.g. Araújo et al., 2011) documenting that the predictive role of RAN in reading performance is stronger in impaired readers than in typical readers. Such results not only underscore the importance of rapid naming skills for readers with reading disability (Araújo et al., 2011) but also support research indicating that RAN and phonological measures predict different aspects of reading (e.g. Savage & Frederickson, 2005; Wolf & Bowers, 1999). At the same time, we can observe a parallelism between the *reading and phonological* factor in the reading disability group, and the *reading and naming* factor in the control group, in that both are composite factors which include more diverse variables and, as such, reflect the complex nature of reading.

In the control group, the loading of NWR (phonological encoding) with accuracy in a separate phonological factor runs against the view that RAN may be just a subprocess of phonological processing, rather than a more independent measure (e.g. Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997). We may still assume that there is a relationship between rapid naming and phonological skills. However, RAN does not depend on single grapheme-phoneme mappings but rather on the access of stored complete phonological forms (for words). If this is true, then rapid naming tasks will predict reading in non-transparent orthographies more than in transparent ones, as indicated by our results for Urdu.

We also observed a considerable difference between the scores of controls and the children from the reading disability group both on the NWR task (cf. Marshall et al., 2001; Mauer & Kamhi, 1996) and all RAN tasks (cf. Wolf et al., 2000). Thus, it seems that both NWR and rapid naming tasks can distinguish between typical and atypical readers. These results not only assert the validity of RAN and NWR as testing and screening tools but also confirm the original grouping (control group and reading disability group) based exclusively on teachers' reports. These original groups showed a significant difference both on fluency and accuracy in both types of schools. Because the original grouping was based on teachers' reports, it also confirms that teachers' reports can be a reliable source for establishing reading difficulties in the classroom. At the same time, we also found that both groups of children from English medium schools were less fluent (though not less accurate) in reading Urdu. A plausible explanation is the greater exposure to the language (Urdu) as the medium of instruction in Urdu medium schools. This amount of exposure puts these children at an advantage, and they become fluent in Urdu reading, apparently, irrespective of social class and background. This confirms our third prediction that increasing the quantity of language input through instruction may facilitate young readers in learning to read that language. More importantly, this is also true for the reading disability group, and the between school-type difference is significant also for the children with reading problems. This finding suggests further that providing more input in the language, which is targeted in reading instruction, can have a preventive role in reading disability. These results are consistent with other results from the same study (Farukh & Vulchanova, in press), where we found that children in both groups from the English medium schools outperformed their counterparts at Urdu medium schools on L2 (English) skills. The finding that increased oral language input can lead to acquiring better reading skills is by no means trivial, because the input is mediated through the auditory medium not the visual one (which would be the one relevant for reading skills). Moreover, little is known about the extent to which environmental factors may exert an effect on learning deficits. Our results provide evidence that increased input may counterbalance the negative effects of reading problems.

It is interesting to note that the children in both groups at the English medium schools did not lag behind on accuracy in reading the Urdu text. There can be three different reasons for this. Firstly, it can be hypothesized that greater exposure to a language improves fluency but not accuracy. Secondly, it might be the effect of exposure to another opaque orthography, which improves their reading ability (Bialystok, Luk, & Kwan, 2005). A third possible account is their superior performance on the NWR task compared with their peers in Urdu medium schools, as revealed by the descriptive statistics (Table 1) and the MANOVA results. This result may simply reflect superior phonological skills in this multilingual group (Perani, 2005). However, it also highlights the importance of phonological decoding in predicting reading and appears to be a more plausible explanation. This finding should be followed in future research on bilingual decoding skills.

CONCLUSIONS

This study has established for the first time that both NWR and alphanumeric rapid naming are strong concurrent predictors of reading skills in Urdu in grade three. Naming speed, as reflected in performance on RAN (letters and digits), underlies both reading fluency and accuracy in Urdu and emerges as the most important factor in reading performance in Urdu. NWR loads independently on a single phonological factor together with reading accuracy. Problems on this task thus suggest underlying problems in phonological competence and the phonological representations necessary for decoding/encoding, affecting the ability to read accurately in Urdu. Thus, these two measures appear to reflect different albeit related aspects of readings skills and, as a consequence, predict different outcomes.

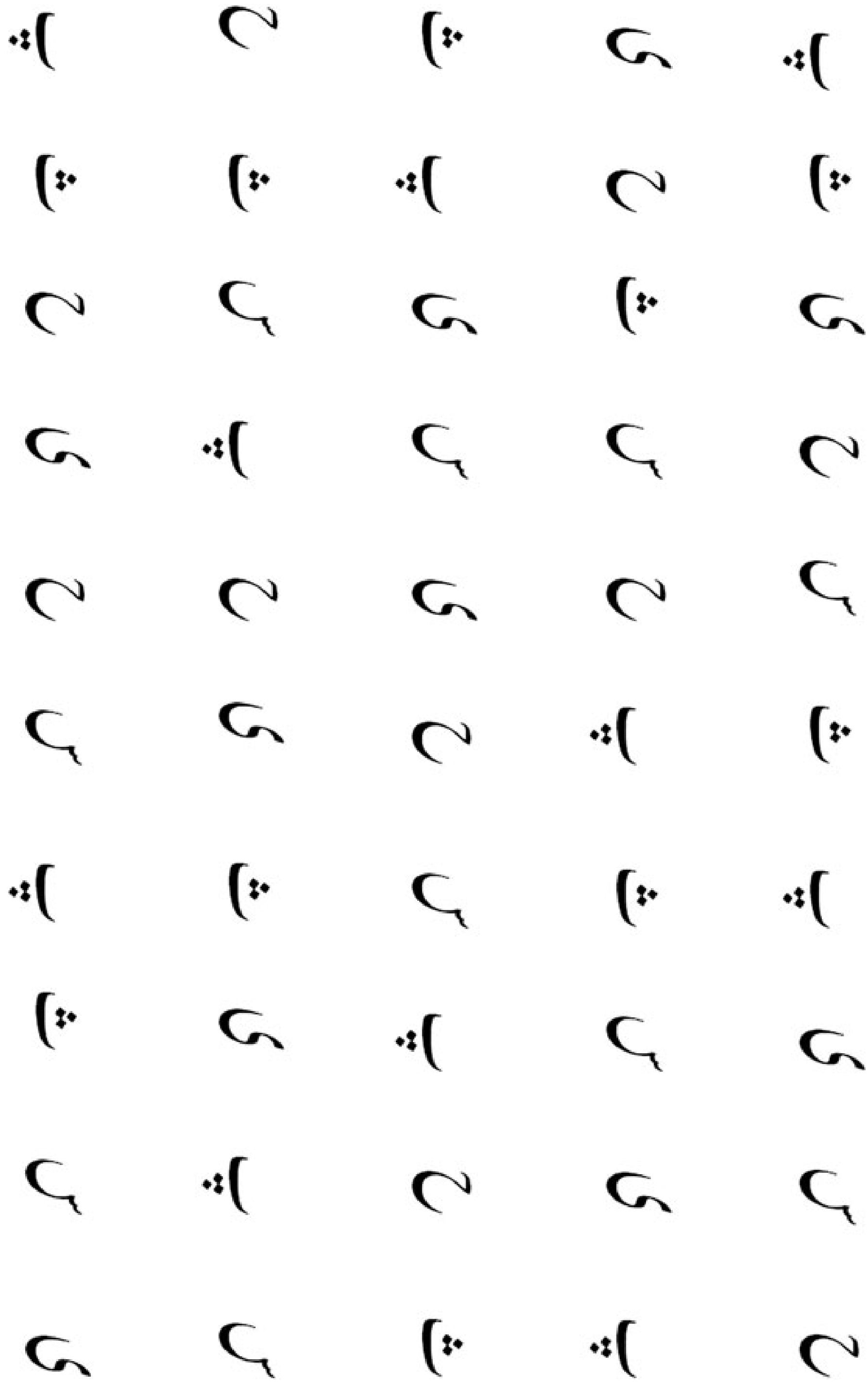
Our data support the predictions of the orthographic depth hypothesis in that rapid naming emerges as a stronger predictor of reading performance overall in both control and RD participants. Still, we do not have a full picture of the dynamics of reading development in Urdu. As suggested by Vaessen *et al.* (2010), reading recruits the same cognitive mechanisms irrespective of the nature of orthography. We see a variation, however, in the dynamics of reading across languages and exactly at what stages of reading development each of the cognitive mechanisms involved exerts a stronger role as a result of orthography. Both children from control and reading disability group from Urdu medium schools had an advantage in reading fluency in Urdu, which suggests that also children with a RD can benefit from greater exposure to the target language of instruction.

We have shown that NWR and alphanumeric RAN tasks can be used for screening children with reading problems in grade 3 in the context of Urdu orthography. Furthermore, teacher's observation is an important and reliable tool in screening children with reading and/or learning problems at the early stages of learning to read (Snowling, Duff, Petrou, Schiffeldrin, & Bailey, 2011). Therefore, raising teacher's awareness about the behavioural symptoms of such deficits is critical.

Our study demonstrates that the complex nature of the Urdu orthography presents specific problems to the child learning to read. Some children never acquire that skill, as shown by the children who were dropped from the current analyses because of not being able to read at all. Timely screening and proper intervention may alleviate such problems. There is evidence that remedial programmes can lead to considerable improvement in reading fluency among children with reading problems (Torgesen, 2005). There must be no reason for children to 'wait to fail' before teachers can begin to implement interventions (Snowling et al., 2011).

Finally, results from our study bear implications for cross-linguistic research on the predictors of reading performance. We provide evidence that the predictors of reading skills (fluency and accuracy) in Urdu are the same as in other languages (e.g. Vaessen et al., 2010; Ziegler et al., 2010), but the strength of relationship might vary with the status of the children (typical readers or children with reading disable). Phonological skills do not appear to be a critical predictor for the reading disability group. In this group, in particular, rapid naming is a stronger factor influencing both fluency and accuracy alike.

APPENDIX A: RAPID AUTOMATIZED NAMING LETTERS SET IN URDU



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NOTES

1. At graduation level, it can be studied as an optional subject.
2. The average age of the children is not calculated because the exact date of birth was not available for all of them from their schools.

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