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Factors related to reading comprehension weaknesses in Persian speaking Primary school children

Amir Sadeghi, [1 & 2*] John Everatt [2] and Brigid McNeill [2]

[1] Islamic Azad University, Damavand Branch (Iran)
[2] University of Canterbury (New Zealand)

The work reported in this paper investigated potential influences of word-level and understanding-level processes on reading comprehension deficits identified in monolingual Persian primary school children. The research contrasted the performance of average comprehenders (N=173) with those with poor text reading comprehension scores (N=33) to identify underlying cognitive deficits associated with text comprehension problems in this language. Two measures of reading comprehension (one involving passage reading and question answering, the other sentence completion) were used to identify reading comprehension weaknesses. Poor comprehenders were considered as those who performed within the bottom 15% of the cohort in both measures. These poor comprehenders were then divided into those with weak decoding skills (one standard deviation below average on a measure of non-word reading) and those without. The performance of the selected groups on measures of phonological and orthographic processing, linguistic ability and speed of processing was contrasted. Findings indicated that children with comprehension problems showed difficulties in language skills related to listening comprehension. Those with additional weaknesses in decoding also showed deficits in phonological areas, whereas those without decoding weaknesses were more likely to show additional problems with orthographic processing. Implications for theoretical perspectives on reading comprehension deficits and practice will be considered.

Key words: Reading comprehension; Poor comprehenders; Persian children

[*] *Correspondence to:*
Dr Amir Sadeghi, College of Education, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand; email: amir.sadeghi@canterbury.ac.nz

Introduction

Early reading acquisition starts with the individual learning to map letters (or graphemes) onto language sounds in order to decode and recognize words. However, reading words accurately is not sufficient for text comprehension. It is also necessary to understand comprehension processes when considering the underlying skills that support text reading. This may be of particular importance when attempting to determine the underlying reasons for reading comprehension difficulties, as in educational assessment practices targeted at children with developmental learning problems. For example, research in the UK suggests that a reasonably large number of children (possibly as many as 10% of primary school children) show a profile of comprehension deficits relative to age-appropriate word reading/decoding accuracy (Cain & Oakhill, 2007; Nation & Norbury, 2005; Yuill & Oakhill, 1991).

This potential dissociation between decoding/recognition and understanding/comprehension can be represented by the simple view of reading (SVR) which emphasizes the importance of decoding and linguistic comprehension processes (see also Bishop & Snowling, 2004; Gough & Tunmer, 1986; Hoover & Gough, 1990; Nation & Norbury, 2005). Children can show variability in one or both sets of skills (i.e., decoding and linguistic comprehension) which will be associated with poor to good reading comprehension. According to the SVR, a child with good skills in decoding and language comprehension should have no reading comprehension difficulties (Hoover & Gough, 1990). In contrast, those who have poor decoding skills, such as children with developmental dyslexia (Castles & Coltheart, 1993), will show poor scores in measures of reading comprehension due to poor written word processing making it difficult to access the meaning of individual work, even when language comprehension is at age-appropriate levels. The opposite profile, as referred to above, is the child with good decoding skills who still has reading comprehension deficits associated with language comprehension weaknesses (Ricketts, Cocksey, & Nation, 2011). Hence, research that aims to investigate the underlying cognitive-linguistic profile of children with reading comprehension deficits (as in the present work) should consider these potentially different sub-groups of learners with reading comprehension difficulties; i.e., those with and without accompanying decoding weaknesses.

Reading comprehension is a multifaceted process that involves many of the skills that are fundamental to human cognition (Kintsch, 1988, 1998). Therefore, comprehension can fail for a variety of reasons that need to be better understood to allow research and practice to develop a poor comprehender profile. The current research aimed to inform the development of such profiles by investigating underlying skills factors potentially related to poor text reading comprehension in primary level children in Iran learning to read and write in Persian. This context was chosen due to the relative lack of research specifically

on Persian reading comprehension difficulties and because of features of the Persian writing system that may lead to skills developing differently from those predicted by current models of reading derived from English. There is a history of identifying reading problems and providing support for those with early literacy learning problems in Iran (see discussion in Tehrani, 2007); however, this has focused on word-level reading and related phonological skills, with interventions targeting phonological decoding processes. Hence, although the term dyslexia is not widely used in Iran, the emphasis is on those difficulties more associated with dyslexia. There is little work investigating underlying factors related to reading comprehension difficulties in young children, which is the focus of the present study.

The Persian orthography has relatively direct (one-to-one) correspondences when translating from graphemes into phonemes in its fully vowelized form – although, there are individual phonemes that can be represented by more than one grapheme, which can create more problems for spelling. The orthography is cursive (most letters change their shape when connecting to letters around them) and uses combinations of dots and marks within and around basic symbol shapes to distinguish letters, determine pronunciation, and represent syntactic rules and morphological forms. In addition, several such marks are used to represent short vowel sounds and these vowel markers are not always included in written text, particularly in passages targeted at readers beyond the beginner stage (after grade one in the present context). The elimination of short vowel markers leads potentially to written text that has a large number of letter strings with several possible pronunciations (i.e., homographs). This means that, at least after first grade, Persian children will need to learn to infer pronunciation and meaning from the context within which a word is written. Hence, the current research focused on young learners of Persian from grade 2 to 5, the early years of reading acquisition when basic skills can be investigated, but following the point (after grade 1) when there is a need to start using text inference strategies to support the accessing of the pronunciation and meaning of individual words. This provides a relatively unique context in which to study the interaction between word-level and comprehension-level processes as well as to consider manifestations of reading comprehension deficits.

The current research, therefore, targeted both word-level and language understanding processes in order to investigate their potential influence on reading comprehension in Persian. As suggested by the SVR, poor comprehenders can demonstrate weaknesses in comprehending orally presented sentences and discourse, which can be assessed by listening comprehension measures (Catts, Adlof, & Weismer, 2006), despite good decoding skills (Nation & Snowling, 2004). However, inclusion of other aspects of language seems also necessary in order to produce a more reliable index of linguistic competence (see Kirby & Savage, 2008; Ouellette & Beers, 2010 for a review). Therefore in the current study vocabulary measures along with listening comprehension were utilized; and

vocabulary has been found to explain unique variance in reading comprehension (Nation & Snowling, 2004). The inclusion of vocabulary and listening comprehension has the added benefit of allowing comparisons of processing meaning related to individual words versus meaning related to text (see discussions in Cain & Oakhill, 2007).

At the word level, reading requires knowledge of print and spoken forms of the language; that is, the rules that relate print to the spoken form (Frost, 2012; Juel, Griffith, & Gough, 1986). Learning to read is learning how one's writing system encodes one's language. This claim reflects the view that reading is fundamentally about converting, or decoding, the graphic input (written characters, letters, words) to linguistic-conceptual objects (spoken words, morphemes, and their associated concepts) (Perfetti & Zhang, 1995). Decoding refers to the ability to translate letters/graphemes into appropriate language sounds.

To decode, the reader needs to be able to apply rules about the relationship between written forms and sounds (such as grapheme-phoneme correspondence rules) that allows retrieval of spoken forms plus meaning from memory. Therefore, a vital part of this process is the ability to recognize language sounds (i.e., phonological information). Early decoding is heavily dependent on letter-sound relationships; letter-sound knowledge is also essential to consolidate orthographic representations required for automatization of silent word reading or sight word knowledge (Ehri, 2005).

However, word processing need not only be performed through phonological decoding. The dual-route model (Coltheart, 1985) suggests that there are two routes to reading aloud: the direct route and the indirect route (Castles, 2006). The indirect route, also known as the non-lexical or sub-lexical route, involves the phonological processes described above and implies that the reader uses grapheme-phoneme correspondence rules to relate letters to their corresponding sounds in order to produce word pronunciation through which access to the lexicon is provided (Coltheart, 2006). The direct (or lexical) route, on the other hand, involves the pronunciation of words from their visual/orthographic form. Words learnt by the reader are stored as specific entries within the lexicon leading to this written form of a word directly activating meaning without the need to convert into a form that the verbal language system can process. This association between the written form of the word and its meaning is arbitrary and must be learnt through experience (Coltheart, Curtis, Atkins, & Haller, 1993).

This model of word reading implies the need to assess two types of word-level processes: one that requires the ability to recognise sounds within words in order to develop the knowledge of grapheme-phoneme correspondence rules used for the indirect route, and one that requires the ability to recognise orthographic word patterns to process written words into the lexicon via the direct route. Variations in the underlying processes of these two routes being related to variations in reading comprehension, particularly for readers matched on their decoding skills,

would also be theoretically interesting. Hence, in order to assess both these areas, measures of phonological awareness and orthographic knowledge were including in the study.

The above word recognition processes are typically measured via tasks that require accurate processing of linguistic material – either verbally presented or written. However, fluent access to word meaning is required in text reading comprehension (Tannenbaum, Torgesen, & Wagner, 2006) and hence measures of speeded processing have also been considered in models related to the SVR (see Joshi & Aaron, 2000, for a discussion of how speed might need to be considered as an additional predictor of reading comprehension independent of linguistic comprehension and word decoding). The inclusion of measures of fluency has been seen as particularly important when assessing literacy levels among children learning more transparent, regular orthographies (Smythe et al., 2008; Wimmer & Goswami, 1994).

Given that early learning of Persian literacy involves the use of vowelized words, which are highly regular in terms of decoding, then fluency may also be predictive of variability in reading levels. However, the relationship between speeded naming and reading may be dependent on whether or not letter strings are the items to be processed quickly. Therefore, in order to study how Persian poor comprehenders perform on rapid naming tasks, the current study included measures of speeded word naming (reading fluency) and speeded object naming (RAN).

Therefore, the current study was designed to further investigate poor comprehender profiles by contrasting different groups of poor comprehenders on their underlying language and word processing skills within a language that has been relatively under-researched, but which uses an orthography that has the potential to produce different relationships between word-level and text -level processes to those found in English.

The skills targeted were derived from a working model of Persian reading (see Sadeghi, Everatt, and McNeill, submitted) based on current models of reading that have been used effectively in cross-language research: specifically the simple view of reading and the dual route model. The measures included in the study were taken from previous work that has involved the development of Persian language materials (see Sadeghi, Everatt, McNeill, and Rezaei, 2014; Sadeghi et al., submitted) and included assessments of reading comprehension and decoding, as well as measures of oral language skill, phonological awareness, orthographic processing and rapid naming.

Hence, the present research provides a basis on which to assess the potential usefulness of models, such as the simple view of reading and the dual route model, for developing ways of identifying children with specific reading comprehension deficits across different languages/orthographies. It should also provide the basis on which to develop assessment tools targeted at identifying children with specific reading comprehension deficits learning the Persian orthography.

Methods

A cohort of 206 Persian primary school children in grades 2 to 5, attending mainstream Iranian school in Tehran, was tested on two text reading comprehension measures: (i) a silent passage reading and question task (similar tasks can be found in Berown, Hammill, & Wiederholt, 2009) and (ii) a passage Cloze completion task (similar tasks can be found in Woodcock, McGrew, & Mather, 2001). Both measures required the child to understand the text in order to perform the task correctly. In the first task, the child was required to read six passages quietly and answer approximately four multiple-choice questions about the passage; a total of 23 multiple-choice questions was used in this measure. Passage length and grade level (i.e., complexity) increased across the six passages. Answers included three distracters and one correct response and questions were either referential or inferential (10 inferential questions and 13 referential questions). In the second task, children were required to read six passages silently and fill in the gaps in the passages with the appropriate word selected from a list of key words (including distracter items) presented at the beginning of each passage. A total of 26 missing words were included in the passages and any misspellings by the children were ignored in marking as long as it was clear that the child meant the correct word. Similar to the first reading comprehension task, passage length and grade level (i.e., complexity) increased across the six passages. Children who performed within the bottom 15% of their grade group in both reading comprehension measures were coded as poor comprehenders. Those who performed above the 15th centile for their grade group on one of the reading comprehension measures but poorly on the other were excluded to ensure that the procedures identified a group of children with poor reading comprehension. This procedure led to a total of 33 (seven grade 2, seven grade 3, ten grade 4 and nine grade 5) children being selected as showing evidence across the two measures of poor reading comprehension. The remaining 173 children were used as a baseline group against which to contrast these 33 children.

The 33 selected poor comprehenders were then divided into two groups based on scores in a task that assessed decoding ability. This task was given to all 206 children and comprised a simple non-word (or pseudo-word) reading task which required the child to pronounce correctly, based on Persian grapheme-phoneme conversion rules, 30 letter strings that were unlikely to be recognised by the child (see discussions of such tasks in Rack, Snowling, & Olson, 1992; and similar measures in Woodcock et al., 2001). To develop non-word items, letters from Persian words were rearranged or replaced so that they were word-like but did not have meaning, and hence would not have a lexical entry. Since, in Persian writing, the short vowels are not usually marked, all acceptable pronunciations (e.g. موک/mu:k/ or /muk/) were considered as correct responses. Participants were given non-words with various numbers of syllables (i.e., non-words with one, two, three or more syllables) and were told that they should try to pronounce the given made-up

words accurately and clearly for the assessor. The time each individual spent on this task and the number of the correctly pronounced items out of 30 was recorded. The latter measure was then used with the correct score to produce a measure of decoding fluency: i.e., the number of non-words pronounced correctly per second. Scores on the non-word accuracy and fluency measures were calculated for the whole cohort to produce a mean and standard deviation for each school grade.

Those children amongst the 33 poor comprehenders who performed one standard deviation below the mean for their grade group on either the accuracy or fluency measures were considered as showing evidence of poor decoding ability. The rest of the 33 were considered as performing the non-word reading task like typical children. This procedure led to 19 (three grade 2, six grade 3, four grade 4 and six grade 5) children with evidence of poor reading comprehension but average decoding skills, with the remaining 14 (four grade 2, one grade 3, six grade 4 and three grade 5) poor reading comprehenders also showing evidence of poor decoding. (Table 1 provides basic demographic information for these two groups and the rest of the cohort of children.)

Once these three groups had been formed, they were compared on a series of measures assessing underlying

i) language skills that focused on meaning,
ii) phonological awareness skills that focused on individual sounds within spoken words,
iii) orthographic knowledge that required an understanding of the Persian orthography, and
iv) speed of processing that targeted the ability to name items as fluently as possible.

The measures of language related skills comprised listening comprehension (similar to that used in Semel, Wiig,

Table 1. Details of the number of participants (numbers of males and females) in each of the three groups, along with mean age and range in months

		Average comprehenders	Poor comprehenders	
			Average decoders	Poor decoders
Sex of child	Male	82	13	9
	Female	91	6	5
Age in months	Mean	112.49	112.36	113.71
	Range	89–136	94–133	92–133

Secord, & Hannan, 2008) and receptive vocabulary (based on Dunn & Dunn, 2007). Vocabulary was assessed using up to 100 verbally presented words (58 nouns, 22 verbs and 20 adjectives) and four pictures visually presented to the child for each word – words had been selected to cover the age range of the children in this cohort. Participants were asked to select one of the four pictures that they considered best matched the meaning of the orally presented word. The listening comprehension measure comprised six passages and 40 yes/no comprehension questions. Referential and inferential comprehension questions were used to measure the participant's understanding of the spoken passages. Similar to the reading comprehension measures, length and grade level of the passages increased throughout the test. The written forms of the passages were not provided. Once each passage was articulated, the participants were asked verbally about the content of the passages – responses were simple ticks on a response sheet that contained nothing more than a question number and yes/no. The spoken Tehrani form of Persian was used in the assessment to reflect the oral nature of the task and to ensure that the accent was familiar to the children. Scores for both listening comprehension and vocabulary were simply the number of items correct.

Phonological awareness was assessed via the child's ability to identify sounds within spoken Persian words. A sound deletion task (simialr to Taibah & Haynes, 2011) required the child to say a word without one of its basic sounds (e.g., repeating the word کتاب/keta:b/, a Persian word meaning book, without the /b/ sound, with the expected correct answer being کتا/keta:/). Fifteen items were developed which varied in their level of difficulty by increasing the number of the phonemes per word (from 5 to 9 phonemes). Phonemes were deleted from the initial, medial or final positions (5 trials each). All items were verbally presented to the child and verbal responses of the child were recorded to determine the number of correct responses.

A second phonological awareness task (based on Tehrani, 2007) involved children being presented verbally with words that they were asked to segment into the component phonemes. For example, the word مسواک/mesva:k/, meaning toothbrush, was said to the child and they were required to state each individual phoneme: i.e., '/m/, /e/, /s/, /v/, /a:/, /k/'. Complexity of the stimuli increased throughout the test by increasing the number of the phonemes per word from those with three phonemes to words consisting of nine phonemes. There were fifteen items in this measure also so that both phonological tasks were scored out of 15.

Of the two orthographic knowledge tasks used in the study, the first required the child to distinguish whether pairs of letter strings were the same or different (as in Elbeheri, Everatt, Mahfoudhi, Al-Diyar, & Taibah, 2011). In this task, differences were kept to a minimum, with pairs differing by only one letter/grapheme (e.g., in English, 'sand send' would be a different pair). The child was required to underline the pairs that were the same. The total number of pairs was 50, and the child was given one minute to

complete as many items as possible. The number of same pairs marked minus the number of incorrect pairs marked produced a score out of 25 which was used as the measure for this task.

In the second orthographic task, the child was required to underline the correct spelling from two sets of letter strings: a word and non-word homophone pair (e.g., in English: 'monk munk'). The non-words used sounded like the word if translated using Persian spelling-sound conversion rules (see Ricketts, Bishop, & Nation, 2008 for a similar task). For example, the word مدرسه/mœdreseh/, meaning school, was paired with the non-word homophone مدرثه which, using grapheme-phoneme conversion rules, would produce the same pronunciation / mœdreseh/. Hence, the child needs to recognise the correct item by its orthographic features, or the direct route, rather than spelling-sound correspondences. The time for this task was one minute with the score being the number of correct responses out of 30.

The final tasks involved the rapid naming of familiar words or objects (see similar measures in Denckla & Rudel, 1976). These tasks required the child to name all the items (35 words or 36 drawings of familiar objects) as quickly as possible, trying to avoid naming errors. The children were directed to name the items from right to left, the direction of Persian writing system, and the participants' ability to name the items without timing was checked prior to testing to ensure familiarity to the level of accurate naming. A stop watch was used and the time the child took to name all the items was recorded in seconds, along with any naming errors. Given the small number of naming errors, time was used as the measure for these tasks.

Results

Tables 2 and 3 present the results of the three groups of readers on the measures

Table 2. Mean scores for each group of readers on the group selection measures, with standard deviations in round brackets and the number of the individuals in square brackets

	Average comprehenders	Poor comprehenders	
		Average decoders	Poor decoders
Passage and questions reading comprehension	12.29 (4.50) [172]	6.36 (3.72) [19]	6.42 (4.07) [14]
Cloze completions reading comprehension	14.96 (6.18) [171]	10.68 (5.42) [19]	8.42 (4.05) [14]
Non-word reading score	28.36 (2.16) [167]	28.52 (1.57) [19]	24.64 (3.62) [14]
Non-word reading fluency	0.59 (.21) [167]	0.63 (.29) [19]	0.31 (.09) [14]

Table 3. Mean scores for each group of readers on the underlying skills measures, with standard deviations in round brackets and the number of the individuals in square brackets

	Average comprehenders	Poor comprehenders	
		Average decoders	Poor decoders
Listening comprehension	32.92 (4.62) [171]	30.35 (4.87) [17]	31.00 (5.09) [14]
Vocabulary (receptive)	74.94 (9.09) [167]	74.21 (10.03) [19]	72.64 (6.19) [14]
Phonological deletion	13.36 (2.03) [171]	12.73 (2.35) [19]	10.00 (4.06) [14]
Phonological segmentation	12.36 (2.09) [166]	11.73 (3.34) [19]	10.76 (2.20) [13]
Orthographic matching words	18.55 (5.47) [169]	14.50 (6.08) [16]	16.35 (7.23) [14]
Orthographic spelling choice	21.42 (7.8) [170]	15.33 (8.49) [15]	17.35 (7.92) [14]
Rapid naming of words	22.15 (8.69) [167]	23.66 (6.13) [19]	35.23 (18.22) [14]
Rapid naming of objects	34.16 (8.62) [167]	35.23 (5.50) [19]	37.12 (6.84) [14]

used in the study. Table 2 included the reading comprehension and non-word reading measures – the measures used to categorise the three groups. Table 3 consists of the results of the remainder of the measures which were used to investigate underlying skills variability across the three groups.

A series of Analyses of Covariance (ANCOVAs) were performed to contrast each poor comprehension group with the average comprehenders on the measures presented in table 3. In each case, school grade and child's sex were used as covariates to account for the effects of educational level in the measures and gender ratio differences across groups. The ANCOVA compared (i) the average comprehenders and the

Table 4. Results of analyses of covariance (with sex and school grade of child as the covariates) contrasting the two poor reading comprehender groups against the average comprehenders

	Average comprehenders vs. Poor comprehenders-average decoders			Average Comprehenders vs. Poor comprehenders-poor decoders		
Measures	F	*df* value	*p* value	F	*df* value	*p* value
Listening comprehension	8.63	1, 184	.004	3.31	1, 181	.070
Vocabulary (receptive)	1.12	1, 182	.292	1.89	1, 177	.171
Phonological deletion	1.65	1, 186	.200	16.84	1, 179	<.001
Phonological segmentation	1.08	1, 181	.299	6.44	1, 175	.012
Orthographic matching words	11.95	1, 181	.001	2.93	1, 179	.089
Orthographic spelling choice	18.55	1, 181	<.001	6.51	1, 180	.012
Rapid naming of words	.85	1, 182	.358	30.01	1, 177	<.001
Rapid naming of objects	.43	1, 182	.512	1.61	1, 177	.206

poor comprehenders with no evidence of decoding weaknesses, and (ii) the average comprehenders and the poor comprehenders who showed difficulties in their decoding skills (see table 4).

The results indicated that the children with poor comprehension levels but average range or better decoding skills showed deficits compared to the average comprehenders on the listening comprehension measure and the two orthographic processing measures. In contrast, the children with difficulties in both reading comprehension and decoding performed poorly, compared to the average comprehenders, on most of the measures except the vocabulary and objects naming tasks; although for listening comprehension and one of the orthographic tasks the differences were non-significant, suggesting that any deficits in these areas were not that severe.

Graphical representation of these results can be found in figure 1, which shows the results of the poor comprehender groups in terms of z-scores. This provides a visual comparison of the average performance of the two groups with reading comprehension difficulties against expected levels of performance represented by the zero line. A z-score for each child was calculated based on the performance of the children within the same school year/grade; that is, the difference between the child's score and the average for the grade divided by the standard deviation for that grade. Therefore, on this graph, the vertical axis indicates the number of standard deviations that each group differed from expected performance on each of the measures. A negative z-score (a score below the 0 line) indicates performance worse than that expected and a score above the line indicates performance better than that expected. Tasks are presented along the horizontal axis, with language understanding measures on the left, followed by phonological, orthographic and speeded naming measures.

Discussion

The ultimate goal of reading is comprehension, which relies on a range of different language and literacy-related skills. Investigations of these underlying

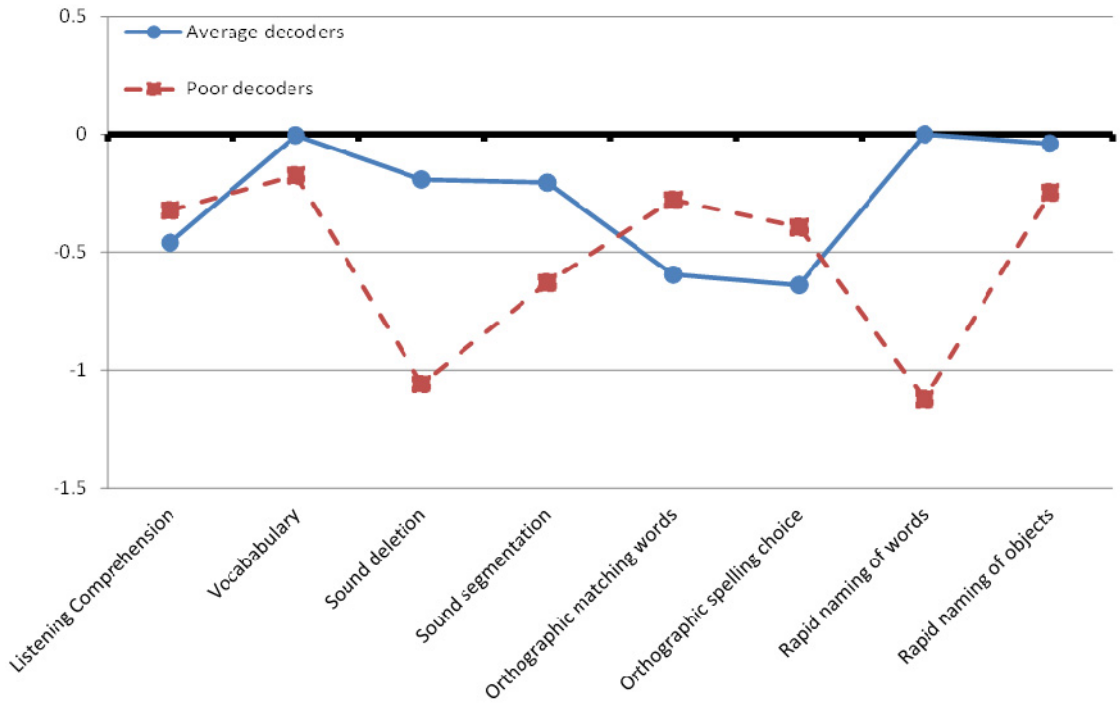

Figure 1. Standard scores of two groups of poor comprehenders on the underlying skills measures in comparison with expected performance

skills should identify those areas potentially responsible for reading comprehension deficits. The current study contrasted different groups of poor comprehenders on their underlying language and word processing skills within the Persian language; a language that has been relatively under-researched, but which uses an orthography that has the potential to produce different relationships between word-level and text-level processes to those found in English.

Overall, the findings argued for poor comprehenders with average to good decoding skills to show more specific deficits in language comprehension and orthographic processing. In contrast, poor comprehenders with weak decoding skills showed weaknesses in most areas of basic processing (phonological, orthographic and speeded written word naming), but fewer problems in language understanding. These findings were generally consistent with the contention, based on a simple view of reading (Gough & Tunmer, 1986), that there should be two types of poor reading comprehenders which show differences, as well as some level of overlap, in underlying cognitive-linguistic processing deficits. The results were also consistent with the Persian model of reading (Sadeghi et al., submitted) in arguing for both linguistic and decoding skills to be important in explaining variability in Persian reading comprehension levels in primary school children. All of the Persian language children with poor reading comprehension levels showed some evidence for weaknesses in language related skills, particularly in the area of listening comprehension, along with problems in their word recognition/ decoding skills.

The data were consistent with studies which have reported that difficulties in receptive language understanding may lead to reading comprehension problems (e.g., Stothard & Hulme, 1992). Interestingly, though, both groups of poor comprehenders showed reasonable levels of receptive vocabulary, with listening comprehension being the main area showing evidence of weaknesses. This suggests that any linguistic deficits would be more likely to be related to processing the meaning of connected text or discourse processing. Such problems potentially focus on inference making or similar concept/meaning linking processes; skills that have been proposed to be associated with this profile of weak comprehension despite good vocabulary (see Cain, Oakhill, & Bryant, 2004).

In the present data, this dissociation between comprehension and vocabulary was most evident in the poor comprehender group with no evidence of decoding problems but weaknesses in orthographic processing, arguing for a link between orthographic knowledge and these semantic linking processes. One potential explanation is that at least some children with evidence of poor reading comprehension skills may be prone to such poor linkage, even within an orthographic lexicon, which would lead to poor orthographic processing. A similar deficit may be evident in a semantic lexicon, leading to poor linkage between entries even when access to a specific entry may be as

accurate as for those without comprehension deficits. An alternative explanation is that there is a reciprocal relationship between good sentence meaning processing and improved orthographic knowledge when exposed to devowelized text. Those with poor reading comprehension will be less able to use text comprehension processes to decipher individual words, which may lead to poor linkage within the lexical system and, hence, to less accurate orthographic retention.

The data also point to evidence that poor word recognition/decoding processes can be related to weak reading comprehension. Children with comprehension deficits showed difficulties in either phonological processing or orthographic processing, which may be consistent with a dual pathway model (Castles, 2006; Coltheart, 1985, 2006). Our findings suggest that those children with poor reading comprehension and associated weaknesses in decoding showed evidence of weak phonological awareness. However, those children with poor reading comprehension and normal range decoding accuracy and fluency showed deficits in measures of orthographic knowledge. These results add to the findings of previous studies (see Nation & Cocksey, 2009; Nation & Snowling, 1998) which have suggested that underlying semantic skills constrain both reading comprehension and the development of word recognition processes. For example, Nation and Snowling (1998) studied children with normal decoding skills but impaired reading comprehension and argued that these children's core difficulty is in their semantic skills. Thus, although these poor comprehenders performed at the normal level on phonological tasks, they showed an impairment of semantics that compromises the use of the semantic pathway (or direct route in the dual route model) and led to poor performance on less frequent irregular words. These Persian data suggest the same potential impairments. A reading comprehension problem in Persian may also interfere with the development of a reliable direct or semantic route to word recognition. The exact reason for this requires further investigation, but again the need to use sentence context to support the access of individual word meaning in devowelized Persian text provides an obvious focus for such future research.

The current work also has potential practical implications, particularly for the identification of children with reading problems. The present data argue that linguistic skills and early word reading processes can be indicative of reading comprehension deficits. Decoding weaknesses associated with phonological deficits in these Persian children seem resonant of profiles of children with dyslexia-related literacy learning problems. Hence, measures of early phonological processing skills (potentially prior to formal literacy instruction) offer the potential to identify reading weaknesses among Persian language children. Additionally, measures of listening comprehension and early orthographic processing also provide a basis on which to develop measures that can identify those at risk of Persian reading comprehension problems. Such specifically targeted measures would have the potential to

dissociate those children with wider language problems that would include poor vocabulary from those with more specific understanding deficits that can lead to problems with text comprehension. Other areas of ability (such as non-verbal skills that may be used to assess, or control for, IQ) may be assessed in future work. Even without these additional measures, however, the current framework provides a basis on which to identify literacy problems, and potential underlying areas of weakness, which should inform assessment procedures.

Clearly, further research is necessary due to the more exploratory nature of the current study: for example, larger groups of poor comprehenders will increase statistical power and may allow explicit comparisons between groups of poor comprehenders, rather than comparing poor comprehenders against expected performance, However, these findings should provide a framework for identification, and more targeted intervention, aimed at those with literacy learning problems among children learning to read in Persian.

Given that the conclusions derived from these Persian language data were consistent with current models derived from English language research, they also provide the basis for further development of cross-language theories and tools that can be used to support children with developmental difficulties across a range of learning contexts.

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