In the Name of God

Language and cognitive factors in learning to read and write among dyslexic and non-dyslexic Persian pupils

Laya Gholami Tehrani

Thesis submitted for the degree of Doctor of Philosophy

Department of the Psychology
School of Human sciences
University of Surrey
United Kingdom
2007
Abstract

The main purpose of this study was to inform the development of screening tools for identifying dyslexia in the Persian language. Measures based on those used in English tests were investigated to assess their relevance for Persian-based assessments. Five studies were conducted. In the first, 140 Persian speaking pupils from five different grades were tested to determine the appropriateness of the measures for use across these grades. In the second study, 64 students were examined with more complex test items to reduce ceiling effects in the data. Overall, the results of these studies suggested a high level of accuracy in text reading in early stages of Persian literacy development. Three further studies then contrasted Persian and English, and dyslexic and non-dyslexic, children. Study 3, in which 40 Persian and 50 English pupils in the third and forth year of schooling were tested, revealed consistency in phonological processing predictors of literacy levels across cohorts. Study 4 compared 36 dyslexic and 58 non-dyslexic grade 1 and 2 Persian children and identified deficits among dyslexic children in literacy and phonological processing. Similar conclusions were derived in study 5, which contrasted differences in performance of year 3 English dyslexics (N=23) and non-dyslexics (N=25) with those found with grade 2 Persian dyslexics (N=16) and non-dyslexics (N=30). These results could be argued to be confirmatory of theories of dyslexia that propose a universal (cross-language) phonological deficit as the primary cause of dyslexia amongst children. However, the studies reported in this thesis also indicated that the Persian learners reached higher levels of accuracy earlier than their English counterparts, a finding more consistent with script-dependent viewpoints. The data are discussed in terms of these
underlying causes and the implications for practice (assessment and intervention) are considered for this relatively under-studied language.
Acknowledgements

I praise the Lord who gifted me with the ability of learning, to read and to write, with which I have worked many years of my life towards aiding dyslexic children in every way that I could in the hope that one day, they too, could enjoy the pleasure of reading and writing. This has been my big thank you.

Next, I would like to remember and thank my first supervisor in the UK, Nata Goulandris who took up the challenge of working with a non native speech therapist, and familiarized me with the current Dyslexia issues. She has greatly contributed to a large section of the literature review which was supervised and edited by her.

However, I was unable to continue with my research for a long time due to my youngest son's illness, until John Everatt, kindly and thoughtfully, encouraged me and made my return easier, while being so supportive all the way, despite all my financial problems and not being able to continue in a full time mode, he was there patiently, considerate and understanding of my circumstances. I wish him a long joyful life.

Then I would like to thank my parents who taught me the love for education and inspired me with their great contributions to the society since my early years. My husband who for many years accepted the unease of being away from his loved ones, so that I could fulfill a dream and finish my PhD in the UK, I am forever thankful.
I know that my findings are only one step from the many steps that should be taken towards treating dyslexic children. But at least, I can say, I took that step. I took it being away from home, going through tremendously painful times, and I could only hope from the bottom of my heart that the outcome of that would be something amazing in these children's lives. The ever growing, most accurate recognition of Persian speaking dyslexic children and their treatment.
Contents

Chapter 1: General introduction and overview of thesis/research .......................... 1

Chapter 2: Literature Review - Psychological Models of reading and dyslexia
2.1 Literacy and phonology ................................................................................. 4
2.2 The dual-route model ................................................................................... 7
2.3 The connectionist model .............................................................................. 10
2.4 Stage models of reading .............................................................................. 13
2.5 Models of dyslexia
   2.5.1 Literacy difficulties and dyslexia .............................................................. 22
   2.5.2 Reading predictors .................................................................................. 25
   2.5.3 The phonological cause viewpoint ........................................................... 26
   2.5.4 Alternative causal viewpoints ................................................................. 29

Chapter 3: Dyslexia in Transparent languages
3.1 Dyslexia and language contexts ................................................................... 34
3.2 Orthographic transparency .......................................................................... 35
3.3 Phonological Differences ............................................................................. 37
3.4 Accuracy versus speed .................................................................................. 39

Chapter 4: Persian orthography And Method of teaching to read and write in Iranian schools
4.1. The Persian orthography ............................................................................ 43
4.2 Method of teaching to read and write in Iranian school ................................ 54
Chapter 7: A cross-language study of Persian versus English children

7.1 Introduction

7.2 Method

7.2.1 Participants

7.2.2 Tasks and procedures

7.3 Results

Discussion

Chapter 8: Dyslexia amongst Persian language children

8.1 Introduction

8.2 Method

8.2.1 Participants

8.2.2 Test materials and procedures

8.3 Results

8.3.1 Differences analysis

8.3.2 Correlation between measures

8.4 Discussion
List of Tables

Table 6.1. Ratio of female (f) to male (m) children of normal pupils from grades 1-5—83

Table 6.2. Means, standard deviations (in parentheses) and the results of Anova and post-hoc tests on the scores of 140 grade 1 to 5 pupils on the measures of phonological awareness and rapid naming---------------------------87

Table 6.3. Means, standard deviations (in parentheses) and the results of Anova and post-hoc tests on the scores of 140 grade 1 to 5 pupils on the literacy measures------------------------------92

Table 6.4. Pearson correlations between age, grade and the measures in the study-----94

Table 6.5. Pearson correlations between the potential literacy predictor measures in the study-------------------------------------------------------------------------96

Table 6.6. Regression analyses for text reading accuracy amongst the grade 1 to 5 children------------------------------------------------------------------------------------97

Table 6.7. Regression analyses for text reading comprehension amongst the grade 1 to 5 children---------------------------------------------98

Table 6.8. Regression analyses for text reading rate amongst the grade 1 to 5 children-----------------------------------------------------------------------------------------98

Table 6.9. Regression analyses for text spelling and word reading and spelling amongst the grade 1 to 5 children-------------------------------------------------------------100

Table 6.10. Means, standard deviations (in parentheses) and the results of Anova and post-hoc tests on the scores of the grade 3 to 5 pupils-------------------------------105

Table 6.11. Pearson's correlation between the measures and age grade of the grade 3 to 5 children.................................................................108
Table 6.12. Regression analyses for the grade 3 to 5 children

Table 7.1. Background details for the Persian and English speaking children in the study

Table 7.2. Means and standard deviations in brackets for the Persian speaking grade 3 and 4 children, and the whole cohort with ranges in square brackets, on each of the literacy and phonology measures

Table 7.3. Means and standard deviations in brackets for the English speaking grade 3 and 4 children, and the whole cohort with ranges in square brackets, on each of the literacy and phonology measures

Table 7.4. Correlations between literacy and phonological processing measures for the Persian (top, right hand section) and English (bottom, left hand section) speaking children

Table 8.1 Ratio of female (f) to male (m) children of dyslexic Persian speaking pupils in grade 1 and 2

Table 8.2 Ratio of female to male children and average ages in months (with standard deviations in brackets) for dyslexics and controls in grades 1 and 2

Table 8.3 Means (with standard deviations in brackets) for each of the measures produced by grade 1 and 2 dyslexic and control children

Table 8.4 Results of analyses of variance investigating the effect of grade and group (grade 1 and 2 dyslexic and control children)

Table 8.5 Pearson’s Correlation between the measures and age for the dyslexic and non-dyslexic Persian grade 1 and 2 children
Table 8.6 Pearson’s Correlation between basic literacy and phonological processing measures for the dyslexic (upper, right hand area) and non-dyslexic (lower, left hand area) Persian grade 1 and 2 children----------------------------------150

Table 8.7 Pearson’s Correlation between text-based literacy and phonological processing measures for the dyslexic Persian grade 1 and 2 children----------------------------------151

Table 8.8 Pearson’s Correlation between text-based literacy and phonological processing measures for the non-dyslexic Persian grade 1 and 2 children----------------------------------152

Table 9.1 English year 3 and Persian grade 2 dyslexic and control children average ages (with standard deviations in brackets) and sex ratio----------------------------------160

Table 9.2 Means (with standard deviations in brackets) for each of the measures produced by Dyslexic and control English speaking children----------------------------------167

Table 9.3 Effect sizes for the dyslexic/non-dyslexic comparisons in the Persian and English language cohorts----------------------------------168
List of Figures

Figure 2.1. General framework for processing of words in reading; the implemented model in bold outline (based on Seidenberg & McClelland, 1989) -------------------------11
Figure 4.1. Characters used to represent Persian sounds that are not found in the Arabic language-------------------------------------------------------------------------------------------------43
Figure 4.2. Persian characters that connect to letters in written text-------------------------44
Figure 4.3. Examples of how Persian characters vary from their isolated form dependent on the position in written text-----------------------------------------------------------------------------------------------45
Figure 4.4. Non-connector Persian characters------------------------------------------------------------------------------------------------------------------------46
Figure 4.5. Examples of the use of dots in the orthography---------------------------------------------46
Figure 4.6. Short vowel markers-------------------------------------------------------------------------------------------------------------------------------47
Figure 4.7. Long vowel characters-------------------------------------------------------------------------------------------------------------------------------48
Figure 4.8. Short vowel sounds represented by long vowel characters--------------------------------------48
Figure 4.9. Examples of written word with several pronunciations------------------------------------------49
Figure 4.10. Characters that represent a single phoneme-----------------------------------------------------49
Figure 4.11. Irregularities in the correspondence between Persian letters and sounds: a single phoneme represented (spelled) by 2 and/or up to 4 different characters---------50
Figure 4.12. Irregularities in the correspondence between Persian letters and sounds: a single grapheme representing more than one phoneme-----------------------------------51
Figure 4.13. Irregularities in the correspondence between Persian letters and sounds: the letter /alef/= ١, representing six vowels--------------------------------------------------------52
Figure 4.14. Example of words that differ simply through the doubling character---------53
Figure 4.15. Comparison of sentences which are the same apart from the unwritten grammatical constraint

Figure 4.16. Categorization of phonemes for auditory discrimination tasks

Figure 4.17. Order of teaching of the letters of the Persian script

Figure 4.18 continued. Order of teaching of the letters of the Persian script

Figure 5.1: Example of a word with a vowel as part of its normal written form, and a word which can be written with or without a diacritic mark

Figure 6.1. Graphical presentation of the level of performance of male and female students across grades 1-5

Figure 6.2. Graphical presentation of the level of performance of male and female students across grades 1-5

Figures 6.3 and 6.4. Graphical presentation of the level of performance of male and female students across grades 1-5

Figures 6.5 to 6.8. Graphical presentation of the level of performance of male and female students across grades 1-5

Figures 6.9 and 6.10. Graphical presentation of the level of performance of male and female students across grades 3-5

Figure 6.11. Graphical presentation of the level of performance of male and female students across grades 3-5 on the reading comprehension measure

Figure 8.1. Word-level literacy measures

Figure 8.2. Text-level accuracy measures

Figure 8.3. Phoneme blending and deletion measures

Figure 8.4. Memory for spoken words and written letters
Chapter 1

General introduction and overview of thesis/research

The development of literacy is an important part of education and a lack of achievement in reading and writing skills can be a major barrier to educational progress and employment prospects. Work that informs the identification of literacy learning difficulties and that will lead to better support of children with such problems should be of benefit to educational as well as the wider society. These practical benefits are mirrored by research into reading and writing abilities/acquisition informing theoretical perspectives which should lead to a better understanding of the area of human ability studied as well as further informing practice. The current work focuses on literacy ability and disability in the Persian language. Currently, much of the research pertaining to the development of reading and writing ability has been conducted with children who speak the English language. However, language features vary, particularly those that relate to the writing system used to represent a language. Consequently, theory and practice developed from this English-language research may not be applicable to other languages and learning contexts. The universality of the findings obtained from English language work needs to be evaluated by investigating literacy development in other orthographies/languages. For example, Moustafa (1995) has suggested that the onset-rime analogy that has been referred to often in the reading research literature might be important for English literacy development, but not for Arabic literacy acquisition, meaning that this area of ability may be useful for the identification of literacy-learning difficulties (dyslexia) in English but may not be useful in the assessment of dyslexia in Arabic. If such findings are correct, they suggest a need to revise theories relating literacy and language, as well as general views about literacy and language development (e.g., Goswami, 2000).
The present thesis considers this area of research from a primarily practical position of informing procedures for the assessment and support of dyslexic children in a particular language context; i.e., children learning to read and write in Farsi, the main language spoken in Iran. The main aim of the work reported in this thesis, therefore, was to investigate whether Iranian dyslexic children show a similar pattern of deficits in the acquisition of reading and writing to those found with English language children. Large similarities between the two would suggest that procedures derived from English-language work should be applicable in Iran. Consistent with the above, the work focused on language-related factors since, as will be specifically argued in the introductory sections of this thesis, these incorporate the current dominant theories of the cause of literacy learning difficulties/dyslexia, as well as being the main area where cross-language differences might occur. Additionally, the work investigates the potential influence of other areas of cognitive skill that have also been argued to be related to literacy development to assess the importance of the language factors against these alternative areas of functioning to the acquisition of Farsi literacy skills. To provide a basis on which to consider these potential relationships, the following introductory chapters present a review of current theories of reading (and writing) development derived from the English-language research literature, as well as an overview of work in other languages, particularly those with a more transparent orthography than English, that indicates how language-related influences may vary across difficult contexts. These more general introductory chapters are followed by an introduction to the features of the Persian orthography and methods of teaching in Iranian primary schools, to provide the reader with an understanding of the context within which the research is conducted.

The data chapters in the thesis start with work investigating normally developing children across the initial grades within Iran. This cross-sectional work looked for changes in literacy
levels, as well as language-related and non-language cognitive skills, across the first five grades in typically Iranian schools. Correlational analyses were used to investigate relationships between literacy levels and underlying language/cognitive skills. Levels of ability and correlations between skills across these initial educational grades were contrasted with those predicted by current theoretical positions. Consistencies between Farsi literacy development and that predicted by English-based models were further investigated in the next data chapter by a specific comparison of Iranian and English children's literacy and language-related skills. Based on these normal development findings, the following data chapter contrasted children identified as dyslexic in Iran against a matched group of normally developing Iranian children. A final chapter then contrasted these Iranian dyslexic/non-dyslexic findings against a similar set of data on English dyslexic/non-dyslexic children. The final chapter of the thesis discusses the results of these data chapters in terms of universal theories of literacy learning, as well as the educational implications of the work for the Iranian educational system, and suggests areas of further research in this and other languages.
2.1 Literacy and phonology

Reading and writing has become one of the most essential skills in the modern, post-industrial world. Even though modern communication systems may provide a means to enhance a child's overall knowledge, reading and writing are still the major tools for the schooling of a child. Although learning to read and write is effortless for most of the children in a classroom, deficiencies in cognitive/linguistic abilities may prohibit a child's progress in the process of learning to read and write (Bryant, 1995; Hatcher, Hulme, and Ellis, 1994; Lovegrove, 1994; Rack, 1994; Snowling & Hulme, 1994; Willows, Kruk & Corcos, 1993). Identifying those abilities that predict literacy acquisition in young children, therefore, is an area of interest to many researchers and educationalists. The evaluation of phonological development in beginning readers may provide a way to discriminate children at risk of reading disabilities and has contributed to an increase in our understanding of reading development amongst most children. There is a large amount of research in English supporting the idea that information about the sounds within words (i.e., phonological awareness) facilitates reading acquisition (e.g., Adams, 1990; Bruck, 1993; Cataldo & Ellis, 1988; Ehri, 1992; Frith, 1995; Gillon, 2004; Goswami & Bryant, 1990; Muter, Hulme, Snowling & Taylor, 1998; Muter, Snowling & Taylor, 1994; Nation & Hulme, 1997; Shankweiler & Crain, 1986; Snowling, 2000; Wagner & Torgesen, 1987). Phonological awareness is assessed by a variety of tasks, which range in difficulty from relatively easy rhyme and alliteration discrimination tasks to more difficult phoneme segmentation, isolation or manipulation tasks (Adams, 1990; Gillon, 2004; Schatschneider et al, 1999; Stahl &
Murray, 1994; Stanovich, 1992), which may relate to the age at which a child is most likely to acquire these phonological skills (Cossu et al, 1988; Dodd & Gillon, 2001; Liberman et al, 1974; Lonigan et al, 1998). However, skills in those tasks that require the child to recognize individual phonemes within words have been considered to develop with literacy acquisition (see Goswami, 2000; Liberman et al, 1974), which means that these phonemic awareness skills may be as much due to literacy acquisition as they are a skill that leads to literacy improvements. Evidence from training studies, which suggests that phonemic awareness enhances later reading skills, has led some authors to consider tests of phonological awareness as reliable predictors of the degree of reading and writing achievement (Bryant, Maclean, Bradecy & Crossland, 1990; Mann & Liberman, 1984; Stuart & Coltheart, 1988; Yopp, 1988). However, the exact direction of the causation is difficult to identify in studies that have focused on children who have already started to learn to read or who have been exposed to reading instructions, as well as those that have included alphabetic materials in their training programmes (e.g., Bradley & Bryant, 1983; Fox & Routh, 1984; Williams, 1980). Indeed, the generally agreed position is that there is a reciprocal relationship between reading skills and phonemic awareness, such that phonemic awareness training can enhance reading skills, and that learning to read in an alphabetical language enhances phonemic awareness ability (Bryant & Goswami, 1987; Cheung et al, 2001; Liow & Poom, 1998; Mann, 1987; Mayringer & Wimmer, 2000; see also Morais, Alegri & Content, 1987).

Another phonological-type assessment measure that predicts reading acquisition is the task of rapid naming. Although it is often classified as a phonological processing variable, it could be classified as a separate factor in predicting reading acquisition (see Blachman, 1994; Wagner & Torgesen, 1987). A number of researchers have shown that among both children and adults, poor readers have slower times, or make more errors, than average readers in tasks where they are expected to name items such as pictures, colours, letters or numbers
A final area of phonological processing that has been argued to be strongly associated with reading ability is short-term memory. Evidence for delayed verbal short-term memory development in poor reading has been obtained on a variety of measures (Brady, 1986; Jorm, 1983; Siegal & Ryan, 1989). The relationship between short-term memory and reading levels is most robust during the early school years, with the possible role in reading of being able to recall information for a short period of time being in learning to identify single words. For example, Baddeley (1986) has suggested that short-term memory may support the decoding of unfamiliar words. When children apply grapheme-phoneme conversion rules to decode words, short-term memory may be used to hold the sequences of sounds in the word so that they can be blended together. Although verbal short-term memory has typically being associated with literacy acquisition (Everatt et al, 1999; Gathercole & Baddeley, 1993; Hulme & Roodenrys, 1995; Wimmer et al, 1998), Meyler & Breznitz (1998) investigated the
relationships between verbal and visual short-term memory and the acquisition of decoding from pre-reading through to early acquisition in 63 Hebrew-speaking children and found that while both verbal and visual short-term memory capacity in Kindergarten predicted subsequent decoding ability, visual short-term memory proved to be a stronger and more consistent predictor. In addition, although Mann & Liberman (1984) have suggested that there is a casual link between short-term memory levels and learning to read, Ellis (1991) has argued that reading ability scores are predictive of later short-term memory scores. One possible reason why this might be so is that reading experience gives the child an additional source of knowledge about words (i.e., spelling knowledge), which they can use as the basis for a memory code (Frick, 1984; Rack, 1985), although a further possibility is that both measures are influenced by a third common factor, such as phonological processing skill (Rack, 1994).

2.2 The dual-route model

One model of skilled reading that incorporates the ideas of directly accessing a name of the visual stimulus as well as the translation of letters into corresponding sounds is the dual-route model (see Coltheart, 1978, 1985; Ellis & Young 1988; Seidenberg 1985). This describes two alternative routes to accessing the meaning of a word. One route involves deducing the meaning of words from their visual form (sight word reading). Any word that the reader has learned is represented as an entry in a mental dictionary or internal lexicon (Coltheart, Curtis, Atkins & Haller, 1993). This implies that words are read using visual analysis of the written form and by retrieving associations between this visual form of the word and its meaning. Letters, or the sequences of letters, are the visual spatial cues in these associations. The associations are arbitrary and have to be learnt through experience. Therefore, this route is facilitated by exposure to words. The direct association of a written form to its meaning and
hence its pronunciation has led to this route being described as the direct route, whereas the idea of a lexical store of visual forms of words has also led to it being described as a lexical route to reading.

The second route in the dual-route model involves phonological processes that allow the application of grapheme-phoneme correspondence rules. This is usually done by first applying the rules that relate letters to their corresponding sounds in order to produce word pronunciations, and then by finding the word that matches this pronunciation form in the lexicon (Baron, 1977; Barron, 1986; Bryant & Bradley, 1980; Frith, 1979; Treiman & Baron, 1983). Therefore, it is seen as a phonological route that connects a written word indirectly to its meaning – i.e., the connection is not via the visual form, but rather via its conversion into a sound form. As such, this route is often referred to as the indirect or non-lexical route to reading. Dual-route theorists have claimed that a reader must have a non-lexical route available for reading aloud in order to be able to read novel letter strings, since the lexical route can only operate following familiarity with a word.

Early versions of the model considered phonological, semantic and orthographic identities of a word as being stored together in a single integrated lexicon (see Coltheart, 1978). However, alternative views (see Morton & Patterson, 1980; Funnell, 1983) have argued for these identities to be stored separately. For example, if a separate lexicon exists, then, when a word is read via the lexical route, the phonology of the item may be accessed directly via the orthographic lexicon or indirectly through the semantic system. Either way, the phonology of the items are accessed post lexically, after the word has been identified, and the graphemic code is used to identify the word directly without any further analysis.
There is still some debate about which words are read by sight and which words are read by phonological conversion. Dual-route theorists claim that sight words are the entire set of words that a reader has learned to access in memory. Irregularly spelled, or exception, words need to be read by sight because they cannot be read accurately through phonological recoding: for example, 'island', 'pint', 'have', 'sword' (Ehri, 1992). High frequency words, by definition, are experienced relatively regularly, so they are thought to be read as wholes instantly by accessing memory. Evidence suggests that readers generally do not use phonological recoding when they have seen a word several times (Gough, 1984). Phonological recoding is usually used for unfamiliar, low frequency, difficult words and nonsense words that have not been exposed to the reader previously. Therefore, skilled readers must produce some kind of mechanism, such as pronunciation rules, which can generate a plausible pronunciation of relatively novel/unfamiliar letter strings such as 'slint' or 'mave'.

It is common to have these two separate reading methods, the lexical based method and the rule based method, represented as two separate pathways. This independence is supported by data gained from studying adult patients who show evidence of an acquired dyslexia. Bub, Cancelliere & Kertesz (1985) reported a patient who showed difficulty in reading exception words, which seemed to be due to the inappropriate application of correspondence rules that led to mispronunciations through regularisations. However, such surface dyslexic patients typically show an ability to apply these rules enabling them to pronounce regularly spelled words and non-words adequately. These findings led to the view that the indirect route is working in such patients but that the direct lexical routes is impaired due to neurological damage.
The alternative, phonological dyslexic cases show evidence of the non-lexical route being impaired. Here, a previously skilled reader would be expected to show normal word reading, particularly of high frequency words, due to the continued use of the lexical route, but an inability to read new, unfamiliar words or non-words (Funnell, 1983) due to an inability to accurately apply grapheme-phoneme conversion rules. Such evidence from acquired dyslexic patients suggests that there is a double dissociation in reading performance, implying that the two routes are independent of each other.

### 2.3 The connectionist model

Traditionally, the alternative to the dual-route approach has been to argue for one system that is directly accessed via the word. This second approach to word recognition has been championed primarily by connectionist modeling theories. There is no place in a distributed connectionist model for something like a lexicon where specific information about a particular input is stored independent from other information. Also, there is no distinction between specific information and general rules in most connectionist models. The main features of this model are the weights and connections between units in the model that are acquired as a result of experience or training, and which are all stored in common network (Plunkett, 1998).

The model implemented by Seidenberg & McClelland (1989) is illustrated in Figure 2.1. What this framework assumes is that reading words involves the computation of three types of codes; orthographic, phonological and semantic. Processing in the model is assumed to be interactive, consistent with the general framework of the Rumelhart (1977) model of reading. However, the simplified implemented model avoided semantic and contextual levels and focused on the connections between orthographic input and phonological output. The
function of these connections is that they carry weights that produce the spread of activation through the system. These weights encode what the model knows about written English; specifically orthographic redundancy and correspondences between orthography and phonology (Patterson, Seidenberg & Maclelland, 1989).

**Figure 2.1.** General framework for processing of words in reading: the implemented model in bold outline (based on Seidenberg & McClelland, 1989)

![Diagram](https://via.placeholder.com/150)

When the model is first started, the connection weights work randomly. Therefore, it can be said that the network has no knowledge of spelling patterns or of the correspondences between spelling and sound. However, the model's ability to generate a correct phonological code comes about through learning. When a word has been presented to the system, the difference between the actual value of each phonological unit and its correct value is computed, with learning being implemented by reducing this difference between actual and correct values.
In its implemented form, the model was trained on monosyllabic words consisting of three or more letters. After training, the model was able to 'pronounce' 97% of the words in its training set correctly. It can be said that the number of training trials on a particular word is proportional to its frequency, consistent with studies, such as Besner & McCann (1987), which suggest that high frequency words are pronounced more quickly than low frequency words. Interaction between word frequency and regularity is a function of this model. This is due to the idea that the connections are required for correct performance and they must be adjusted more frequently in the required direction for frequent words (because they are presented more regularly) and for regular words, because they make use of the same connections as other, neighbouring, regular words (Patterson et al., 1989). This means that high frequency and regular words will be read more quickly than low frequency and exception words (Seidenberg & McClelland, 1989).

Models which incorporate separate lexical and rule based routes to reading suggest the potential for confusions between competing pronunciations of exception words. For example, the lexical route would lead to the word 'lose' being pronounced correctly; however, via the non-lexical route a pronunciation that rhymes with 'rose' would be specified. Therefore, to avoid such confusions, many dual route models assume that the correct pronunciation of an exception word by the lexical route is produced too quickly for the competing (incorrect) pronunciation generated by the grapheme-phoneme conversion rules. Such explanations do not fit the data that well, however. Similarly, although the original connectionists models were often seen as reproducing those words that they had been taught in a way which mimics the performance of skilled readers, they have been seen as poor at generalising pronunciations to new, novel words or non-words – basically, they do not read non-words as well as a skilled reader. Connectionist networks are seen as poor at pronouncing new words...
because they do not have specific rules about pronunciations and are poor at lexical decisions because they lack representations of information about specific words (Rolls et al, 1998). These problems with both types of models have led to more hybrid theories that incorporate elements of both dual routes and connectionist features (e.g., Coltheart et al, 2001; Plaut et al, 1996).

2.4 Stage models of reading

Developmental theories focus on the effects of age on skill acquisition. Changes with age are seen as biologically and/or culturally determined, with important roles being played by both genes as well as educational systems (Frith, 1986). These theories indicate and describe how and in what order knowledge and skills are acquired. The order in which skills can be acquired is particularly important for those theories that focus on stages of acquisition. In terms of reading development, one of the most influential stage theories was proposed by Marsh and his colleagues (e.g., Marsh et al, 1981). This cognitive-developmental stage theory divided reading development into four separate stages. The first stage involves linguistic substitution, in which the child may have a rote memory for a few highly familiar words, like their name, but can only guess at unfamiliar words using the context within which the word is presented (i.e., a linguistic guessing strategy for reading new words). For example, a child may guess at a related word that fits into the context but which does not show any graphemic features in common with the presented word (saying ‘spaceship’ for ‘rocket’).

The second stage is called discrimination net substitution. Here rote memory is still the basis of reading familiar words; however, guesses are now based on visual letter cues as well as the linguistic context (reading ‘house’ as ‘home’ because it has the same initial letter). Therefore, unfamiliar words will be identified on the basis of visual similarities (discriminating between
different words) with a net of familiar words. This can be contrasted with stage three, the sequential decoding stage, in which the child uses phonological information to support reading. Now the focus is on a decoding system to address unfamiliar words. In this initial decoding stage, a sequential (in English) left-right mapping process is used, which means that beyond relatively simple word structures ('cog', 'car', 'kitten') there are frequent mispronunciations, particularly with irregular words ('cough', 'care', 'knit'). However, in the fourth and final stage, the hierarchical decoding stage, more complex decoding rules are used, enabling a more flexible approach to reading unfamiliar words. In this final stage the analogy strategy first appears. When reading by analogy, new words are pronounced based on a knowledge of words with similar spelling patterns. Thus a child who knows how to read the word 'beat' can through the process of analogy, infer the pronunciation of similarly spelled words like 'meat', 'heat' (Muter, Snowling & Taylor, 1994).

The four different stages that Marsh et al identified may not necessarily be characteristic of every child. However, they do provide a fairly reasonable description of many children's reading progress, particularly in terms of the sort of error patterns found amongst children of different ages (Rayner & Pollatsek, 1989). However, it also has the disadvantage that the skilled reader is considered to access words via a phonological-related decoding strategy, which does not seem to reflect the reading characteristic of skilled adult readers who, in dual route terms, seem to be able to access lexical entries directly without conversion to a phonological form.

An alternative, equally influential stage model, has been suggested by Frith (1985). This incorporates three stages, which starts with a logographic or visual whole word recognition strategy, similar to Marsh et al's second stage, before moving to an alphabetic or decoding
stage that employs letter-sound conversion strategies similar to those used in Marsh et al’s later stages. However, more consistent with current views about skilled, adult reading, Frith’s model proposes a third and final orthographic stage, which depends on the segmentation of orthographic and/or morphemic units larger than the single letter/grapheme. Hence, in this final stage, decoding into phonemes is less crucial for skilled reading.

Logographic skills refer to instant word identification on the basis of noticeable graphic features. It is typically the first letter that acts as the salient feature, although other letters can do so too. Letter order is largely ignored and phonological factors are entirely secondary. This strategy means that the child pronounces a word only after recognising it, leading to non-responses if recognition does not occur—although contextual and pragmatic cues may be used to form a guess in some cases. It is assumed that this look-and-say strategy is avoided when the storage has reached a critical limit and visually similar words become confusing.

By now, the child may have learnt some relationships between letters and sounds, such as that the words ‘fish’, ‘fog’, ‘fast’ all have the same initial sound and are spelt with the same initial letter. By this stage, the child has now moved into the next stage of development in which they abstract and use letter-sound correspondences. The alphabetic stage is characterized by the child being able to analyse words into their component letters and sounds, as well as being able to blend individual sounds to produce a whole word pronunciation. Letter order and phonological factors play a crucial role. This strategy enables the reader to pronounce (though not always correctly) novel and nonsense words. When children enter this stage, they may be observed to sound out the letters in a word separately and then recombine them to produce the actual word. The start of this stage is characterized by the occurrence of semi phonetic spelling. This normally omits vowels. Letter sounds will be used to represent syllables. When children have shown that they can spell phonetically
(e.g. ‘orange’ is written ‘ORINJ’), this indicates that phonological awareness skills are
developing normally (Stackhouse & Wells, 1997) and that children have learnt to divide
words successfully and apply letter knowledge; however, they will still not have learnt the
conventions of English spelling which need to be developed to become a successful
reader/speller. These conventions are based in the skills learnt as part of the orthographic
stage. This final stage is characterized by the child’s reading becoming independent of
sounds and an immediate analysis of words into orthographic units. There are two possible
definitions of what an orthographic rule is. One is that learning about any spelling sequence
that cannot be decoded on the basis of single-letter sound associations is in time orthographic
learning. This definition implies that the sequence “ight”, for example, is an orthographic
sequence (Bryant, 1995). The second definition states that there are conditional rules. The
child has to learn that a sound may be represented in one way under certain conditions and
differently in other conditions. For example we usually represent the final morpheme in past
verbs with ‘ed’ even in words such as ‘mixed’ or ‘waited’, which end with a /t/ sound or with
an /id/ sound in their spoken form. Conditional rules are more complex than straightforward
associations between letters, or letter sequences, and sounds. Therefore, a child may only
manage to learn such conditional rules after they have mastered the alphabetic code. The
orthographic strategy is distinguished from the logographic one by being analytic and by
being non-visual. It is distinguished from the alphabetic stage by operating in larger units
(such as morphemes) and by being non-phonological. Frith’s model states that children enter
the orthographic stage initially in reading and then in spelling since the many irregularities in
the English orthographic system makes spelling development very difficult, particularly for
the strategies used in the alphabetic stage. For the child to understand these irregularities and
to deal with them successfully, they must transcend the phonetic principles of one sound
being represented by each letter, which dominate the alphabetic stage, and must enter the orthographic stage, when spelling is by larger units or morphemes.

Unlike the Marsh et al model, Frith's view is compatible with models of skilled adult reading performance. It is also possible that this model is compatible with a dual-route account of skilled reading. Children develop their non-lexical route in the alphabetic stage. The orthographic stage is where they develop their orthographic lexicon. The orthographic stage is one where direct visual access is on the basis of complete descriptions of words. Adult readers, as in the dual-route models, are conceptualised as having both routes operational but for most words the direct lexical route will dominate, unless there are problems, in which case the alphabetic strategy may lead to a pronunciation and the accessing of potential meaning. The model is developmental with the alphabetic stage being a necessary pre-cursor to the orthographic stage.

Ehri's (1992) developmental stage model may be seen as more along the lines of a connectionist viewpoint, though whereas the connectionist formulation focuses on the nature of the access route into memory, and the kinds of connections that are formed linking spelling to pronunciations, Ehri's theory focuses more on the nature of the spelling representation that is established in memory when these connections are formed (Ehri, 1992). Ehri's model distinguished four stages. The first, pre-reading or emergent reading stage begins during the pre-school years when the child develops an understanding of the purpose or functions of written language. Reading readiness may be indicated by the child picking up a book and telling a familiar story or rhyme to an adult, pet or toy (Stackhouse, 1989). In this stage, children begin recognising words in their environment but have little knowledge of letters. Connections between written words and meaning are formed through arbitrarily
salient visual cues seen in or around a word, which are linked to the meaning and pronunciation of the word in memory, independent of phonology. Consistent with this, several studies have shown that logographic readers are able to read words by remembering visual cues with little attention to letters in the words (Ehri, 1984; Goodman and Altweger, 1981). Unless sight words are learned during this stage, the visual cues forming the connections tend not to be unique to individual words and so children mistake visually similar words for one another. This is because the visual cues are connected to the meaning of the word rather than the pronunciation. Similarly, writing that is practiced by scribbling or copying print may lead to children inventing their own spellings.

There are two factors that may be used to predict how well children read during the next stage. The first of these factors is knowledge about names of letters and the second factor is phonemic segmentation skills (Juel, Griffith, & Gough, 1986). These measures are said to be more reliable predictors than measures of intelligence and story listening experiences. Indeed, a study by Lundberg, Frost, & Petersen (1988) showed that pre-readers who were trained to segment speech into phonemes before they received any reading instruction, learned to read and spell better than the control subjects who did not receive this training. The use of phonetic cue reading is an initial decoding phase of the rudimentary alphabetic stage. Here the child may learn the names or sounds of most of the letters of the alphabet and attain low-level phonemic awareness. During this stage, a beginner reader uses their letter knowledge to form visual-phonetic connections between letters seen in spelling and sounds identified in pronunciations of words: for example, in learning to read the word ‘bill’, they realise that ‘b’ connects with /b/ and that ‘ll’ connects with /l/ in the pronunciation of the word. These two connections are stored in memory, which enables the child to access the word’s pronunciation the next time they see its spelling (Ehri, 1992). The reader must acquire
phonetic segmentation skills to understanding that there are separate sounds in the articulations of words and also in letter names (e.g., /I/ versus 'el'). Recognising first and final sounds in pronunciations is much easier than detecting sounds in the middle of words, such as the /I/ sound in 'black' (Treiman, 1985). This may lead to the beginner reader misreading a word such as 'face' as 'fare'. By having experience in reading different words, and with special training to detect sounds in blends (Ehri & Wilce, 1987), correspondences between letters and sounds should be acquired. When phonemic segmentation skills improve, access routes connecting spellings with pronunciations in memory will be formed, which should lead to more reading confidence than in the earlier stages, given more systematic connections between spellings and pronunciations, rather than more arbitrary connections between visual features and meaning.

The next stage is the more mature alphabetic phase, which was termed cipher reading. This phase is achieved by setting up connections in memory across entire sequence of letters, as well as between sequences of letters and blends of phonemes. The connections are elaborated due to the development of part-part and part-whole connections. Because the English orthography symbolises the phonemic structure of language more closely than the phonetic structure (Ehri, 1992), cipher readers do not make errors that are phonetically valid. Rather, errors are phonemically wrong, because they have learned how the phonemic system works. Some of this knowledge has come from their experiences with speech but also some of it has come from learning how the spelling system symbolises speech phonemically. One of the characteristics of this stage is that cipher readers know how to analyse pronunciations into a sequence of phonemes. They can analyse the phonemic function of all the letters in a word’s spelling and store these connections in memory in order to use them in recognising the printed word. Segmentation skills and phonological recoding are used in a mature manner to
form complete visual-phonological connections in learning to read sight words (Ehri, 1992). Although cipher readers may make very few mistakes compared to younger decoders, confusions in reading similarly spelled words can occur. However, a feature of this stage is that the reader becomes more fluent in their reading skills. They become faster and more skilled in decoding unfamiliar words, they reading familiar words with greater speed and less effort, and they are more able to coordinate word identification and text comprehension processes in a more efficient manner. To facilitate this development, practice is essential. This decreases the amount of attention required on individual words and increases the resources available for coordinating words with text comprehension processes (Dewitz & Skilliter, 1989). When readers are in the fluency stage, they learn a great deal of words. Word attack skills grow as the reader receives more decoding instructions and they recognise common spelling patterns in the sight words they learn to read (Venezky & Johnson, 1973). By doing this, they cannot only read the words in front of them accurately but automatically and quickly. In the final, skilled stage, the reader can not only read well and fluently but also is able to take in information and comprehend difficult materials, even if these materials are unfamiliar. This stage involves learning new information, new knowledge, new thoughts and new experiences. The material read is more demanding than in the previous stages and the ideas are less familiar. Intelligence is more highly correlated with reading skills at this stage than the earlier stages (Singer, 1977). This stage is the determiner on how well someone reads compared to another, and also the differences between good and poor readers (Juel, 1988).

The descriptive stage models of literacy development are made up of sequences of stages or phases with respect to motor, cognitive, language, perceptual and normal development. However, they may not necessarily be characteristic of every child. There is a question of
how and when these children go through these phases. Stuart & Coltheart (1988) have suggested that the stage dependant view of reading development may not be totally tenable. They present evidence that some children who are phonologically aware appear to be able to read using an alphabetic strategy from the beginning, whereas other children have to use a visual approach as their initial strategy. Children using an alphabetic strategy as a starting point made the fastest and most effective progress towards skilled reading. Additionally, Wimmer & Hummer (1990) found absolutely no evidence for logographic processing in Austrian children learning to read German. Iranian children showing progress in phonological training (especially blending and segmentation of phonemes) before learning to read and write have been found to begin learning a few initial words by the look and say method but they enter the alphabetical stage at the same time (Tehrani, 1995). In other words, it could be assumed that there is no independent logographic stage in their reading development. The method of teaching children to read may have an effect here. For example, the logographic stage may only be observed in those children starting to learn to read with a whole word method, such as look and say. Those children, such as Iranian children, who start learning to read with a phonic method may miss the logographic phase and move straight into the alphabetic phase.

Similarly, individual differences between children may play an important role in determining whether they go through a logographic stage or not. For example, Baron & Treiman (1980) and Baron et al (1980) argued that there were two types of readers amongst the normal English speaking children that they assessed. ‘Chinese’ readers used a great amount of word-specific associations when they wanted to read or spell; their reading may be described as ‘visual’. Such children also made meaning preserving errors (e.g., reading plausible as possible), suggesting that they directly accessed the semantic memory system at word
recognition. On the contrary, ‘Phoenicians’ relied heavily upon spelling-sound rules. They are better in sound categorisation tasks in comparison to Chinese subjects. ‘Phoenicians’ show characteristics similar to readers said to be in the alphabetic phase (Snowling, 1987).

Finally, the age at which children are required to begin reading instruction may be an important factor in the strategies that they are able to use when attempting to pronounce words. It may be that the logographic phase in reading is observed when children begin to read before they have developed cognitively to the point where they can use a translation code (Byrne, 1992). They may have to resort to memorizing visual features only because they have no other strategy available. However, if they were to start reading when they had developed the cognitive ability to use a translation code then they may be able to translate letters into sounds from the outset of learning to read and write and, therefore, would not go through the logographic stage.

Overall, despite their problems, a large number of models of reading skill/acquisition argue for the importance of the child being aware of the relationship between letters and sounds, and therefore being able to identify those letters and sounds. For the majority of the positions presented, skills in visual letter recognition and phoneme awareness would seem important aspects of the process of learning to read and write. Given this, it seems likely that problems with the acquisition of literacy would be related to deficits in the processes that support these recognition/awareness skills.

2.5 Models of dyslexia

2.5.1 Literacy difficulties and dyslexia

There are numerous views on what dyslexia is and this has led to a large number of
definitions. Rather than covering all these positions, this discussion will focus on a few
alternatives that are particularly relevant to the current work. Two general frameworks will
be considered. The first focuses on the behavioural outcome of dyslexia – specifically, its
consequences for educational achievement. The second framework is based on theories as to
the cause or causes of dyslexia. Examples of both of these general positions will be
discussed.

A Working Party of the Division of Educational and Child Psychology of the British
Psychological Society (British Psychological Society, 1999) came to the consensus view that
dyslexia should be considered as a problem with developing word reading and/or spelling
that is accurate and fluent. This definition specifically avoids causal viewpoints and focuses
on the most obvious education-related behavioural outcome of dyslexia; i.e., literacy
acquisition problems. One potential problem with this position is the over-inclusiveness of
this definition. All children with a problem with learning to read and write would be defined
as dyslexic under this relatively simple criteria definition. Even this position goes on to argue
that educational opportunity needs to be considered – i.e., a child who has not had the
opportunity to learn to read and write would be excluded from this viewpoint. Similarly, this
position goes on to focus on literacy at the word level, rather than at the level of
understanding meaningful text. This suggests that a child with an understanding problem who
can read isolated words well may be excluded from the dyslexia diagnosis. A final problem is
that, traditionally, dyslexia has been considered in terms of a discrepancy from more general
ability, with many viewpoints arguing for the specific nature of the dyslexic’s problems (see
Thomson, 2001). Under the BPS (1999) more encompassing definition, all children,
irrespective of their general ability, would come under the dyslexia label if they presented
evidence of literacy learning problems.
Alternative positions that still focus on the behavioural outcome use more exclusion criteria, typically focusing on the intelligence of the child. One of the most quoted definitions derived from meetings of the World Federation of Neurology (Critchley, 1968) and led to the view that a dyslexic was someone who did not attain literacy skills that equate to their intellectual abilities. The World Health Organisation (1993) ICD-10 criteria specified this position more clearly by stating that a specific reading disorder is determined by reading accuracy (or comprehension) being at least two standard errors below an IQ-based expected level. This had the advantage of specifying the level of difficulty quantitatively. However, problems arise when using IQ as part of any diagnostic criteria. For example, although theorists such as Miles (1997) and Tonnessen (1995) have concluded that a discrepancy can be informative when used as suggestive of a specific difficulty, they have also noted problems with this as a criterion measure. For example, there are problems due to determining the nature of intelligence -- different views about intelligence will lead to differing criteria for diagnosis. This is particularly relevant for dyslexia assessments since such individuals typically show skills in some areas of an IQ assessment but not in others (see Miles, 1993). The choice of IQ test measures, therefore, may under or over estimate the condition. Similarly, the discrepancy model would only makes sense if there was a strong correlation between the IQ and reading. However, as Stanovich (2000) has noted, the correlation found between IQ and reading varies from study to study, depending upon the measures used, and evidence is inconclusive that there is a reliable relationship between general IQ levels and literacy ability. The main argument against the IQ-based definition though has been the lack of evidence for differences between groups of high IQ and low IQ children with reading deficits in all except the measures on which the IQ score was derived (see Ellis et al, 1996; Share, 1996; Siegel, 1988), thereby questioning the logic of separating these groups of poor readers.
A further difficulty with the educational outcome viewpoints is its need to await failure (see discussions in Lyon et al, 2001). Dyslexia assessments are required to wait until a difficulty in acquisition or a discrepancy with IQ levels has been established, which may lead to formal support being delayed. An alternative approach has been to provide additional features (symptoms) in the dyslexia definition by which to determine the level of likely risk of failure. An example of this approach was the British Dyslexia Association (Peer, 2001) viewpoint that describes dyslexia as a combination of abilities and difficulties, with weaknesses in speed of processing, short-term memory, perception, language and motor skills being considered in addition to the usual literacy problems. The idea that the dyslexic has abilities as well as difficulties provides a possible distinction between those with specific deficits and those with more general difficulties. However, such a large range of accompanying difficulties has the problem of again under-specifying the condition, and a consistent list of core symptoms has yet to be developed (see Smythe & Everatt, 2004). In contrast, the International Dyslexia Association (quoted in Masland, 1997) focuses on dyslexia being characterized by difficulties in single word decoding, which reflect insufficient phonological processing abilities. This position considers a core, causal factor underlying the dyslexic's difficulties in reading and writing, and this causal phonological deficit has become a dominant hypothesis in the field (see below).

2.5.2 Reading predictors

Given that most of the views of dyslexia discuss reading problems, the starting point for the identification of dyslexia would seem to be the determination of what predicts reading acquisition, particularly as such predictors may avoid experiences of failure to acquire. Consistent with the phonological deficit viewpoint, research into predictors of success in
reading English has identified the ability to process phonological units (phonological awareness), as well as an understanding of the alphabet and its relationship to language sounds, as reliable predictors of English literacy skills (Adams, 1990; Badian, 1994; Bryant & Bradley, 1983; Cunningham, 1991; Gallagher, Frith and Snowling, 2000; Gillon, 2004; Martino & Hoffman, 2002; Muter & Snowling, 1998; Siegel, 1993; Scarborough, 1990; Stevenson & Newman, 1986; Wagner and Torgesen, 1987; Wasik, 2001; Whitehurst & Lonigan, 2001). Such evidence has led to the view that specific reading deficits are likely to be the result of a breakdown in those language processes related to phonological processing that provide an awareness of the link between letters and sounds (see Snowling, 2000; Stanovich, 1988; Stanovich & Siegel, 1994). However, other areas of individual differences have also been found to predict aspects of reading (see Baddeley, Logie, Nimmo-Smith & Brereton, 1985; Conners & Olson, 1990; Engle & Conway, 1998; Everatt & Underwood, 1994; Gottardo, Siegel & Stanovich, 1997; Jackson & McClelland, 1979; Palmer, MacLeod, Hunt & Davidson, 1985; Perfetti, 1983; Ransby & Swanson, 2003; Siegel & Ryan, 1988).

Hence, although phonological processing and alphabetic knowledge seem to be the best predictors of early literacy skills (word reading and spelling), other areas of functioning may be vital, particularly when a wider range of literacy skills are considered. These alternative areas have led to alternative causal hypotheses to the phonological viewpoint and, therefore, the phonological causal position needs to be considered in the light of these alternative models.

2.5.3 The phonological cause viewpoint

The principal causal hypothesis, derived mainly from research on reading and writing English, has been the phonological deficit hypothesis (see Stanovich, 1988). This perspective has been derived from the substantial evidence that phonological skills form an integral part
in the acquisition of English word level literacy (Bryant and Bradley, 1985; Rack et al, 1994; Siegel, 1993; Snowling, 2000; Stanovich, 1988). Evidence has also been provided that similar relationships between phonological processing and literacy can be identified in studies of languages other than English (Alegria, Pignot and Morais, 1982; Bentin, Hammer and Cahan, 1991; Ho and Bryant, 1997; Lundberg, Frost and Peterson, 1988; Torneus, 1984). Additional support for the phonological perspective has come from studies which have indicated that early phonological training (together with suitable linkage to early orthography and literacy experience) can substantially improve word literacy (Bryant and Bradley, 1985; Byrne and Fielding-Barnsley, 1993; Cunningham, 1990; Elbro et al, 1996; Hatcher et al, 1994; Lie, 1991; Olofsson and Lundberg, 1985; Schneider et al, 1997; Tangle and Blackman, 1992; Torgesen et al, 1992; Warrick et al, 1993). Difficulties in phonological processing have also been a major distinguishing factor between dyslexics and non-dyslexics matched for age and reading level (Rack et al, 1992; Snowling, 1981), and these difficulties have been associated with dyslexia throughout development and into adulthood (Beaton, McDougall and Singleton, 1997; Bruck, 1993; Elbro et al, 1994).

However, despite the wealth of data supporting the phonological deficit hypothesis, it is not without its difficulties. It has yet to be confirmed whether an isolated phonological perspective provides a model that will work with the diverse nature of scripts found around the world. The relationships between rhyme familiarity and orthographic transparency identified amongst speakers of English, French and Spanish have led Goswami, Gomber and de Barrera (1998) to conclude that different orthographies may represent words at different levels of phonology dependent on their level of transparency. Transparency here refers to the correspondence between letters (graphemes) in the script and sounds (phonemes) within the language. A highly regular or transparent orthography (such as Hungarian) would have a
simple or shallow relationship between written symbols and language sounds, such that one symbol would represent one sound. Most orthographies have some irregularities in the relationship between written symbols and language sounds; however, languages vary in their relative transparency, with a language such as English having one of the least transparent (opaque or deep) orthographies, whereas languages such as German have a more transparent (regular or shallow) orthography. Evidence has suggested that experience of a relative regular orthography may lead to a greater use of phonological encoding, or sub-lexical processing, in skilled reading and literacy acquisition (see Goswami, 2000; Smythe, Everatt & Salter, 2004). Learning a relatively transparent orthography may also lead to a higher level of proficiency in tasks that require phoneme awareness. In contrast, decoding a less transparent orthography may lead to lower scores in phoneme-based tasks and require the reader to use a range of phonological skills to support learning, as well as potentially leading to poorer general scores on measures of decoding. Amongst English speaking cohorts, literacy has been found to be related to novel letter string decoding, phonological awareness at the level of the rhyme and phoneme, retention and manipulation of phonological information and the rapid accessing of phonological forms, with deficits in these same tasks being characteristic of poor readers who show evidence of a typical English dyslexic profile. These findings can be contrasted with several studies of scripts that are more transparent than English. Everatt, Smythe, Ocampo & Gyarmathy (2004) found that measures of phonological awareness could distinguish English speaking children with and without literacy deficits, but were much less reliable at distinguishing those with and without literacy problems in Hungarian. Wimmer, Mayringer & Landerl (1998) concluded that children with a predisposition towards dyslexia who are learning a relatively transparent orthography would show weaknesses on measures of naming speed and phonological memory more clearly than on tasks of phonological segmentation and pseudoword reading. Such findings are consistent with differences across
languages in terms of the relationship between literacy ability and phonological skills, with more transparent languages being less likely to show associations between poor awareness, weak decoding skills and difficulties in reading acquisition.

One way to explain these effects within the phonological deficit perspective is to conclude that an awareness of sounds within words, the ability to decode written symbols into sounds, the ability to store and/or manipulate phonological forms and the ability to retrieve/produce verbal labels are all types of phonological processing that can be subsumed under the one phonological framework. However, one problem with this argument is that these processes may add independent variance to literacy (Wagner and Torgessen, 1987), questioning their inclusion within a unitary causal framework. Further research, therefore, is necessary to distinguish which languages differ in respect of the relationships between phonological processes and literacy, as well as to identify the language factors that may lead to such differences.

2.5.4 Alternative causal viewpoints

The evidence discussed above (Everatt et al, 2004; Wimmer et al, 1998) suggests that the ability to store phonological forms for short periods of time or to rapidly access familiar phonological labels may be better at predicting literacy deficits amongst children learning a more regular orthography than measures of phonological awareness. These findings suggest that the inability to recognise sub-word units (e.g., phoneme or rimes) within a word may not be a universal cause of dyslexia, thereby questioning the appropriateness of the phonological deficit hypothesis as an explanation of literacy acquisition difficulties across languages. Given that phonological memory and rapid access may also explain individual differences in literacy ability amongst English language students, these findings suggest that alternative
causal models may be more appropriate as cross-language explanations of literacy deficits. Indeed, there are models that argue for memory or rapid access processes being a causal explanation of literacy deficits.

Various studies (see Gathercole and Baddeley, 1993; Wimmer et al, 1998) have suggested that children who experience difficulties with retaining sounds in short term memory are likely to have problems with the acquisition of verbal vocabulary and development of stable graphic-sound associations. Such processes may be important in reading and listening comprehension, as well as in language acquisition (Daneman, 1991; Daneman & Carpenter, 1980; Gathercole, Willis, Emslie & Baddeley, 1992). Indeed, there is evidence that the short-term recall of phonological information is a characteristic feature of dyslexia (see Catts, 1989; Humle & Mackenzie, 1992; Katz & Shankweiler, 1985; Mann and Liberman, 1984; Thomson, 1990). However, such relationships do not specify the direction of causality and it may be that reading problems lead to poor short-term memory performance (see discussions in Hulme & Roodenrys, 1995). Similarly, there is evidence for the equivalent performance of dyslexics and non-dyslexics on measures of short-term recall that do not require the processing of verbal (or auditory) information (see Gathercole & Pickering, 2001; Jeffries & Everatt, 2003). As such, it may be that phonological short-term memory is specifically impaired in dyslexics leading to deficits in processing new language information, such as learning new letter strings or a new vocabulary (Gathercole and Baddeley, 1989; Gathercole, Willis & Baddeley, 1991). But this position seems indistinguishable from the general phonological deficit viewpoint discussed above, and rather than being an alternative is often seen as complementary (see Bishop & Snowling, 2004).
The phonological deficit viewpoint has also been considered to encompass the speeded retrieval of verbal labels (i.e., rapid naming deficits). However, alternative theoretical positions have argued for this skill to be evidence of a speed of processing weakness amongst dyslexics. Evidence for rapid naming deficits have been found in a multitude of conditions, including word and non-word items such as colours, line drawings/pictures of familiar objects, digits, letters, and pseudowords (see Ben-Dror, Pollatske & Scarpati, 1991; Bowers & Wolf, 1993; Denckla & Rudel, 1976; Spring & Capps, 1974; Wolf & Bowers, 2000; Wolf & O'Brien, 2001). Consistent with its potential importance as a predictor of literacy levels, longitudinal studies have shown that, not only is rapid naming predictive of later reading performance (Wagner, Torgeson & Rahotee, 1994), but that naming deficits persist into adulthood (Felton, Naylor & Wood, 1990). However, naming deficits can be found in the number of errors produced by dyslexic individuals, particularly when objects with low frequency names are used (Swan & Goswami, 1997). These findings suggest that poor naming performance may not be due to a speed of processing deficit but to poor representations of the verbal labels, which is more consistent with a phonological deficit perspective. In order to explain problems specifically associated with phonological processing, while retaining the idea of a speed of processing deficit, Wolf and colleagues (Bowers and Wolf, 1993; Wolf and Bowers, 2000; Wolf and O'Brien, 2001) have proposed that there are distinct sub-types of dyslexia that are based on the occurrence of phonological and/or speed of processing deficits. This double deficit hypothesis is consistent with longitudinal findings that phonological and rapid naming tasks predict unique variance in reading attainment (Cronin & Carver, 1998; deJong & van der Leij, 1999) and with evidence from intervention programmes that train fluency in word identification strategies showing improved reading skills among reading disabled children (Lovett et al, 1994; 2000; see also...
Wolf, Miller & Donnelly, 2000) – although it still needs to be shown that these interventions specifically targeted speed of processing.

Other theories that have been categorised within the general phonological deficit perspective have focussed on auditory (perceptual-based) processes (eg, Tallal, 1980; Tallal and Katz, 1989; Tallal et al, 1997). This work is also related to the speed of processing ideas, since deficits are usually discussed in terms of problems processing rapidly changing auditory information. Consistent with the auditory deficit perspectives, there has been evidence that the ability to categorise speech sounds is more difficult for the dyslexic individual than the average reader (Serniclaes et al, 2001; Sutter et al, 2000), and a number of researchers (Helenius et al, 1999; Lorenzi et al, 2000) have confirmed the role of auditory temporal processing in speech processing and argued that differences in such processes may be detectable at birth (Leppanen et al, 1999). McCrory et al (2000) found that dyslexics showed deficits specific to auditory repetition. However, dissociations between verbal and non-verbal processing (Adlard and Hazan, 1998; McAnally and Stein, 1996), and evidence against auditory deficits leading to all types of phonological processing problems (Heath et al, 1999) have cast doubt on a simple auditory deficit perspective. Therefore, more recent alternative perceptual accounts have incorporated visual processes in their theoretical frameworks. Historically, the main alternative to the language-based, or phonological, theories have been the visual processing deficits theories (see Everatt, 1999). However, these have taken many forms, which have suffered from a lack of clarity about the causal pathway to literacy problems and have often led to contradictory arguments (see discussions in: Hogben, 1997; Everatt, 2002; Goulandris et al, 1998; Rayner & Pollatsek, 1989; Wilkins, 2004). The main visual hypothesis that has presented a challenge to the phonological position is that dyslexia is caused by a dysfunctional transient or magnocellular pathway that leads to blurred vision.
due to inappropriate interactions with a normally functioning sustained or parvocellular visual system (see Breitmeyer, 1993; Lovegrove, 1996). However, in its current form, this visual deficit viewpoint has also failed to provide a plausible account of dyslexia (see Skottun & Parke, 1999; Vellutino, Fletcher, Snowling, & Scanlon, 2004).

The combined visual and auditory perceptual deficits viewpoint returns to the view that dyslexia is produced by a temporal processing deficit (see Stein, 2001). Although evidence for such auditory deficits have been difficult to replicate, particularly with children with specific reading difficulties (see Marshall et al, 2001; Mody et al, 1997), they are consistent with findings for deficits in the processing of rapidly changing visual information that have been used to argue for a transient or magnocellular deficit (e.g., Lovegrove, 1996). These commonalities have led theorists such as Stein (2001) to combine visual and auditory temporal processing deficits within the same theoretical framework. Such a deficit might lead to visual and/or auditory deficits and, thereby, explain the variations in difficulties evident in the visual and phonological literature described above. This framework may also combine with perspectives that have proposed timing and/or automaticity deficits related to the activity of the cerebellum (Fawcett and Nicolson, 2001) and, hence, explain the range of deficits found in the performance of English dyslexic children by Nicolson and Fawcett (1996). However, weaknesses in each element of the theory need to be resolved and the potential interactions between visual, auditory and motor factors need to be specified, before this can be considered a sufficient explanation of dyslexia.
Chapter 3

Dyslexia and literacy difficulties in transparent languages

3.1 Dyslexia and language contexts

Within the UK, dyslexia is typically seen as problems related to the acquisition of literacy (BPS, 1999; though see Gersons-Wolfensberger & Ruijssenaars, 1997, for similar views from a non-English speaking context). However, as discussed in the previous chapter, literacy problems need to be considered in terms of the background of the child. A child who has experienced a problematic educational background may lack reading and writing skills, but would not necessarily be considered as dyslexic. It is also the case that an individual who has learnt to speak a different language from that in which they are expected to be literate will, at least for some period of second language learning, show evidence of poor literacy skills. Again, such a situation would not normally be equated with the problems experienced by the dyslexic, nor would support necessarily be the same for the second language learner and the dyslexic. Specification of the underlying cognitive or experiential factors that might be leading to observed literacy problems may be important in determining the appropriate support procedures to implement (see discussions in Bishop & Snowling, 2004; Miles, 1993; Thomson, 1990). However, with the world-wide awareness of specific learning disabilities, dyslexia and associated literacy problems, and increased mobility of groups between language communities, there is the necessity for assessment procedures that are applicable across many language contexts (Smythe and Everatt, 2004), as well as research that considers the appropriateness of test measures/materials across a range of language contexts (Cline and Reason, 1993; Cline and Shamsi, 2000; Smythe and Everatt, 2002). Given the availability of English-language screening tools, simply translating tests from English to other languages has provided one means to find a solution to the lack of non-English test measures. For
example, Everatt, Smythe, Ocampo & Veil (2002) discuss how the assessment of underlying cognitive/linguistic processes, particularly those related to phonological skills, affords the potential to distinguish dyslexic individuals from those who are reading in an additional language, despite equally poor literacy skills being presented by both groups (see also Everatt, Smythe, Adams and Ocampo, 2000; Frederickson and Frith, 1998). However, developing test procedures based solely on factors related to one language can lead to disadvantages. Learning to read in one language is not necessarily the same as learning to read in another. It may be that the nature of script to be learnt leads to different processes being required for its acquisition and skilled use (Katz & Frost, 1992). As such, there is no reason to believe that the best predictors of literacy will be the same across all languages or scripts, nor that the underlying (cognitive) causes of literacy difficulties will be identical for all languages/scripts. Additionally, aspects of the language or culture within which an individual is immersed may make an assessment measure inappropriate for inclusion. Research is needed to show that models of literacy developed in one language (typically English) are applicable to other literacy learning contexts, particularly across other languages/orthographies.

### 3.2 Orthographic transparency

The transparency of an orthography refers to the degree of correspondence between written symbols and the language sounds that they represent. In some orthographies, this relationship is relatively simple: there is close to a one-to-one correspondence between the written symbol (grapheme) and the basic sound (or phoneme) that it represents. In other orthographies, this correspondence is less transparent: a letter may represent several sounds, and a particular sound may be presented by different letters, depending on the context within which the letter or sound is presented. The English orthography is the best example of this less than
transparent or opaque relationship between letters and sounds (see Katz & Frost, 1992). In contrast, languages such as French, Greek, German, Spanish and Italian (Arroyo, 1989; Bruck, et al., 1997; Cossu, 1999; Eisenberg, 1988; Harris & Giannouli, 1999) are much more regular in their letter-sound correspondences and would be considered as relatively transparent orthographies despite some exceptions from the normal association of letters and sounds. Additionally, there are some languages that have a consistently transparent orthography (Hungarian is a good example here; see Smythe et al, 2004), but these are, in the main, relatively new orthographies (for example, many African orthographies) which have not experienced the level of language change that often leads to exceptions – Turkish provides an interesting, relatively modern example of the regularization of an orthography.

The potential importance of orthographic transparency can be seen in cross-language comparisons of reading ability that contrast scripts varying on the transparency dimension. In the majority of such studies, the rate of literacy learning, particularly word reading/decoding, has been found to increase with the level of orthographic transparency. This has been found in comparisons of different language groups (see the Cost A8 work reported in Seymour et al, 2004), although differences in terms of the cultural importance of literacy learning or educational practice could also explain these effects. However, similar results have been found amongst bilinguals learning two orthographies of differing transparency (Everatt et al, 2002; Geva & Seigel, 2000; Veii & Everatt, 2005). Typically, these findings point to word recognition and non-word decoding processes developing faster in the more transparent orthography. For theories of literacy development, such data have been discussed in terms of less transparent orthographies potentially requiring several processing systems (a sub-lexical route for words that can be decoding via letter-sound correspondences and a lexical route for words that are exceptions to these correspondence rules), whereas languages with a relatively
transparent orthography can rely on letter-sound or sub-lexical procedures for word recognition. Such dual-route perspectives have been influential in cross-language theorizing (see, for example, Coltheart, Rastle, Perry, Langdon & Ziegler, 2001) and are closely related to the Orthographic Depth Hypothesis (Katz & Frost, 1993), which argues for differences in literacy acquisition, and lexical and sub-lexical influences, across languages of different orthographic transparency (though see Baluch & Besner, 1991; Barry & Bastiani, 1997; Oney, Peter & Katz, 1997; Raman, Baluch & Besner, 2004; Taouk & Coltheart, 2004). In addition to potential differences in literacy processes, evidence for a relationship between the rate of literacy improvements and orthographic transparency may indicate that the child will experience fewer problems with learning a more transparent orthography than a less transparent one, leading to dyslexia being less evident in languages that use a relatively simple relationship between letters and sounds.

3.3 Phonological Differences

As discussed in the previous chapter, reading development, at least for an alphabetic-type script, is dependent on phonological awareness, particularly its influence on the decoding processes argued to be an important part of literacy learning development. However, given variability in transparency, the importance of this decoding process may vary across orthographies and, hence, the importance of phoneme/phonological awareness may also vary. These potential cross-orthography differences bring into question the universality of the dominant phonological deficit causal viewpoint of dyslexia. If phonology is less important for learning literacy in some languages, then phonological deficits may be less important. Although there is some support for the cross-language generalisation of the phonological perspective (Goswami, 1999; 2000) there is a need to test this hypothesis across a range of languages. For example, it has been argued that 50% of Chinese dyslexics do not have a
phonological deficit as assessed by English derived measures (Ho et al, 2002). Everatt et al (2004) found that although alliteration and rhyme phonological awareness tasks could distinguish groups of grade 3 children with and without literacy deficits in English, they could not distinguish reliably similar groups of Hungarian children. The same reduction in the ability to distinguish between good and poor literacy learners has been found for decoding skills amongst German learners (see Wimmer, 1993). These findings suggest the need to consider different tests measures in dyslexia assessments across languages, but they also casting doubt on the link between phonological awareness, phonological decoding and weaknesses in literacy. Overall, when it comes to distinguishing children with and without literacy learning problems in a relatively transparent orthography, other measures apart from those specifically used to assess phonological awareness may be better identifiers. From the phonological perspective, these alternative measures may be measures of rapid naming or short-term/working memory. However, other measures such as visual processes, which have been seen as the traditional alternative to the phonological viewpoint, may help explain variability in literacy skills if a cross-language perspective is considered. For example, Ho (1994) found that visual discrimination skills (especially constancy of shape) and visual memory skills at three years old were, along with phonological awareness, significant predictors of reading Chinese at four and five years old. Similarly, McBride-Chang and Ho (2000) have suggested that speed and phonological awareness are important predictors of Chinese character recognition, and that slow naming speeds are associated with poor visual attention as well as letter knowledge. Similar relationships have been found between literacy difficulties and weaknesses in visual processing tasks in studies of Arabic (AlMannai & Everatt, 2004; Elbeheri & Everatt, 2007). Additionally, Gupta and Garg (1996) found that dyslexic Hindi/English bilinguals produced poorer visual discrimination scores than non-dyslexic bilingual controls and a similar result was found by Everatt et al (2000) with
Sylheti/English bilinguals. As with much of this evidence, both groups of bilinguals also
presented evidence of differences between good and poor readers in measures of
phonological processing, which may be more consistent with combinations of visual and
phonological deficits as factors influencing literacy levels.

Overall, the above evidence suggests that, at the very least, in order to account for current
cross-language findings, and retain phonological deficits as the main characteristic of
dyslexia across languages, the phonological deficit hypothesis has to incorporate more than
phonological awareness measures as a characteristic feature of the deficit, but has yet to
provide an explanation that incorporates these disparate tasks and explains their variability
across languages (though see Zeigler & Goswami, 2005, for one attempt at this cross-
language level of explanation).

3.4 Accuracy versus speed

A second feature that has been found to vary with orthographic transparency has been the
specific literacy weaknesses that distinguish good and poor literacy learners. The
developmental model of Goswami and others (see Goswami, 1999; 2000; Ziegler &
Goswami, 2005) has suggested that phonological processing skills develop along with
literacy learning. For example, Goswami (1999) presented evidence (Goswami, Gombert &
De Barrera, 1998; Goswami, Porpodas & Wheel-Wright, 1997) suggesting that the
phonological units that correspond to the vowel and subsequent consonants of a word or non-
word (e.g., /ink/ in ‘think’ or ‘nink’) were most salient to young English readers in comparison
to young French readers, but were not salient to young Spanish and Greek readers who
seemed to show more evidence of a sensitivity to phonemes. Based on these findings,
Goswami (1999) concluded that children learning a relatively transparent orthography
develop an awareness of phonemic units at a very early stage of the learning to read, and much earlier than expected based on data from studies of less transparent scripts (see also Ziegler and Goswami, 2005). If this is the case, a poor reader with a weakness in phonological awareness (a dyslexic child under the phonological deficit viewpoint) may not be as disadvantaged when learning a relatively transparent orthography compared to their counterparts having to decode a less transparent orthography with a much more complex relationship between letters and sounds. A dyslexic child might be able to rely on relatively simple grapheme-phoneme association rules to support decoding. This simplicity of association may not task the weak phonological system as much as an orthography with a more complex and irregular correspondence between graphemes and phonemes. Indeed, given the reciprocal relationship between literacy learning and phonological skills (Lukatela, Carello, Shankweiler, & Liberman, 1995; Morais, Cary, Alegria, & Bertelson, 1979; Share and Breznitz, 1997), learning a more transparent language may lead to improvements in the phonological processing skills of the dyslexic (Everatt et al, 2002). Hence decoding skills may be better developed in the dyslexic learning to read a more transparent language, leading to reading accuracy been relative good compared to that presented by dyslexics learning a less transparent orthography. Consistent with this, evidence suggests that word reading accuracy may be less of an identifier of dyslexia in more transparent orthographies. For example, Landerl, Wimmer & Frith (1997) compared the reading abilities of English and German dyslexics and found that, although the reading accuracy of poor readers from more transparent orthographies was higher than those of poor readers from less transparent orthographies, the German dyslexics presented evidence of slow reading speeds (see also Cossu, 1999; Wimmer, 1993). This finding suggests that phonological decoding deficits can be overcome to some extent by a slow process of translating letters into sound. However, if reading is slow, due to weak phonological decoding, then general reading efficiency may
suffer potentially leading to poor understanding of text (reading comprehension deficits), less experience of new words (lower vocabulary levels) and a lack of enjoyment of reading that may lead to de-motivation to improve reading and spelling skills (Everatt et al, 2002; Snowling, 2000; Stanovich, 1987). Hence, the identification of dyslexia amongst children learning a relatively transparent orthography may have to rely on alternative measures to the word reading accuracy tasks typically incorporated in assessment procedures (see discussions in Elbeheri et al, 2006; Everatt et al, 2002). The most likely alternative is reading rate; i.e. the number of words or non-words that can be accurately decoded in a set time. If phonological decoding weaknesses can be offset by slowing the decoding process, accuracy will be improved but rate will still remain slow compared to expectancy levels.

However, a second potential reason why rate of reading may be a better identifier of dyslexia in a relatively transparent orthography returns to one of the problems with the universal phonological deficit viewpoint. Put simply, this weakness in rate may be due to slow speeds of information processing. If the processing system is generally slow, then word identification and hence reading rate will also be slow. This may lead to slow literacy learning, weak vocabulary and a lack of enjoyment in literacy – much the same argument as above. As such, dyslexia in some (or all) languages may be due to poor speed of processing rather than weaknesses in phonological decoding processes (see discussion in the previous chapter). This explanation is consistent with evidence that good and poor literacy learners in some orthographies differ on rapid naming measures but not on phonological awareness tasks (eg, Everatt et al, 2004), as well as research which suggests that rapid naming measures may be a good identifier of literacy deficits/dyslexia, particularly when relatively transparent scripts are considered (Di Filippo, Brizzolara, Chilosi, De Luca, Judica Pecini, Spinelli, & Zoccolotti, 2005; de-jong & van-der-Leij, 1999; Guardia, 2003; Korhonen, 1995; Landerl,
2001; Wolf, Pfeil, Lotz, & Biddle, 1994). Wimmer (1993) found that amongst German speaking children, rapid naming of numbers was the largest predictor of variance in speed of reading text and non-word reading. Relatively slow rapid naming speeds were characteristic of German dyslexic children, even though they generally do well on reading accuracy. In the Landerl (2001) study, also on German speaking dyslexic children, it was found that rapid naming tasks showed a much stronger relationship with measures of reading speed, whilst phoneme tasks were mainly related to reading accuracy. Similarly, Saiegh-Haddad (2005) found that the strongest predictor of reading fluency in vowelized Arabic was letter recoding speed, which was itself predicted by measures of rapid naming, as well as phoneme isolation.

As discussed in the previous chapter, Wolf and colleagues (Bowers and Wolf, 1993; Wolf and Bowers, 2000; Wolf and O'Brien, 2001) proposed that there are distinct sub-types of dyslexia based on the occurrence of phonological and/or speed of processing deficits. Hence, some poor readers are considered to have phonological processing deficits with no speed of processing problems, while others show the reverse symptomatology, and a third group show problems in both areas. The double deficit group is considered to show the most problems in literacy skills development. Such multiple causal views also present the possibility of differences in the factors associated with dyslexia across languages. Where phonological decoding may be key to literacy learning, phonological processing deficits may be the main identifiable characteristic of dyslexia. Where rate is the defining characteristic of poor literacy, speed of processing deficits may be more associated with identified dyslexia. Hence, the features of the language or script that a child is acquiring may determine the influence of disabilities or weaknesses on the manifestation or identification of dyslexia (see discussions in Smythe & Everatt, 2004). However, again this perspective requires empirical evidence across different language cohorts.
Chapter 4
Persian orthography And Method of teaching to read and write in Iranian schools

This chapter aims to provide a context within which to understand the research undertaken. The majority of the work was performed in Iran, with children who were Persian speakers, and the focus of the research was to understand dyslexia and literacy difficulties within this context. Therefore, this chapter provides background information about the Persian language, focusing on the writing system used to present the language, as well as the education system and literacy teaching methods experienced by the Iranian children.

4.1. The Persian orthography
Detailed descriptions of Persian orthography can be found in Khanlari (1979) and Baluch (2005). Persian has adopted the Arabic alphabet with some modifications. This particular alphabet is a cursive script, with most of the letters being connected to each other in normal written text and it should be read from right to left. The script consists of a total of 32 letter characters. They include 28 Arabic characters plus 4 additional characters that represent the four Persian phonemes not found in Arabic. These additional characters are presented in Figure 4.1.

Figure 4.1. Characters used to represent Persian sounds that are not found in the Arabic language

/P/ ب ؛ / Č / چ ؛ / Ž / ژ ؛ /g / گ
Important features of Persian characters are (i) their shape, (ii) the number and position of the dots above or below a shape, and (iii) the position of the character within a word (i.e., initial, medial or final position). The shape and dots provide the distinctive features of the Persian letters; however, the exact shape of a letter varies dependent on its position within a word. Hence, a letter in isolation will present one form, but when placed in a word may vary in this full form, particularly when it is connected to adjacent characters. Additionally, Persian characters can be divided into two types, referred to as connectors and non-connectors, which also affects their representative form within written text. Twenty-five of the 32 characters are considered as connectors because, when written within words, they are connected to their neighbouring graphemes preceding them on the right or following them on the left. These are presented in figure 4.2.

Figure 4.2. Persian characters that connect to letters in written text
Examples of how the shape of a connector letter, when it appears in the initial, medial, or final position, can vary from its full (isolated) form are presented in Figure 4.3. As shown, a connector may appear in long (full) form or short form depending on its position in the word, as well as the neighbouring characters. Typically, the short form of a connector letter is found at the beginning or middle of a word, allowing it to connect to following letters more easily in written text.

Figure 4.3. Examples of how Persian characters vary from their isolated form dependent on the position in written text

<table>
<thead>
<tr>
<th>Full Form</th>
<th>Final</th>
<th>Medial</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N) ن</td>
<td>(N) من</td>
<td>(N) نـ</td>
<td>(N) نـ</td>
</tr>
<tr>
<td>(That) آن</td>
<td>(I) من</td>
<td>(Name) منصور</td>
<td>(Pray) نماز</td>
</tr>
<tr>
<td>(Kh) خ</td>
<td>(Kh) خـ</td>
<td>(Kh) خـ</td>
<td>(Kh) خـ</td>
</tr>
<tr>
<td>(Palace) کاخ</td>
<td>(Thread) نخ</td>
<td>(Name) بختيار</td>
<td>(Good) خوب</td>
</tr>
<tr>
<td>(Y) ی</td>
<td>(Y) یـ</td>
<td>(Y) یـ</td>
<td>(Y) یـ</td>
</tr>
<tr>
<td>(Normal) عادی</td>
<td>(Tray) سینی</td>
<td>(Fine) نیک</td>
<td>(One) یک</td>
</tr>
</tbody>
</table>

Non-connector letters do not connect to neighbouring characters and always appear as full form (see Figure 4.4).
Hence, the learner of the Persian script needs to be able to identify most letters from their full and short forms, as either could be presented in a word dependent on the characters around the letter. Similarly, the Persian learner needs to be able to be aware of the use of non-connector letters in order to distinguish spaces within and between words. These features may lead to a potential additional letter recognition load on the Iranian child that models of English literacy acquisition may not account for.

The use of dots is also a major feature of the Persian writing system. The same graphemic base shape may represent a different consonant depending on the number and place of the dots. Fourteen letters (base shapes) of the writing system do not carry any dots, but the rest (18) include one, two or three dots to the base shape to represent a new grapheme (see examples in Figure 4.5).

Figure 4.5. Examples of the use of dots in the orthography
In addition to recognising characters, current models suggest that learners of an alphabetic script need to be aware of the connection between the letter and its corresponding language sound. The use of the Arabic script to represent the Persian language may lead to difficulties becoming aware of this connection for the Iranian child. Differences between the Persian and Arabic languages lead to a less than regular correspondence between individual characters and individual phonemes. Similarly, although long vowel sounds are represented by three of the 32 Persian characters, the feature of most Semitic derived orthographies to represent short vowel sounds by optional diacritic markers (contrast Figures 4.6 and 4.7) leads to variations in the depth of the orthography experienced by readers dependent of whether the markers are included or not. In most text, particularly those experienced by adult-level readers, there is no grapheme representation for the short vowels – diacritic spelling is only used for beginner readers, as fluent readers are accustomed to reading script without the diacritics (it is similar to reading vowel free Hebrew; Birnboin, 1995).

Figure 4.6. Short vowel markers

\[
\begin{align*}
\overline{a} & ; & \overline{Ma} & \hat{a} \\
\overline{e} & ; & \overline{Me} & \hat{a} \\
\overline{o} & ; & \overline{Mo} & \hat{a}
\end{align*}
\]
A further complication occurs with the use of long vowel characters to represent short vowel sounds as in the examples presented in figure 4.8.

The discrepancies between the graphemic system and the vowels may be considered as a major source of reading problems and ambiguity for a beginner learner of Persian in reading and writing (when diacritics are omitted). For example, the same graphemic representation may have different pronunciations (see figure 4.9). In most cases, it is the linguistic context, as well as the meaning of the word, which would specify the phonological representation of the word.
Another major source of difficulty is the lack of one-to-one correspondence between some of the consonants and their representing characters (graphemes). Only 16 of the characters represent a single phoneme each (these are presented in Figure 4.10).
In the rest of the cases some sort of discrepancy exists between the consonant (phoneme) and its representing grapheme – examples are presented in figures 4.11 and 4.12. A special case here is the letter /alef/ = ١, which at the beginning of a word or in combination with /u/ and /i = ee/ can represent six vowels (see Figure 4.12).

Figure 4.11. Irregularities in the correspondence between Persian letters and sounds: a single phoneme represented (spelled) by 2 and/or up to 4 different characters

/h/ ح
/s/ س
/z/ ض ذ ز
Figure 4.12. Irregularities in the correspondence between Persian letters and sounds: a single grapheme representing more than one phoneme

/šir/ شیر /i/

/yâl/ یال /y/

/do/ دو /o/

/tup/ توب /u/

/savâr/ سوار /v/

/rowšâhan/ روشن /ow/
Figure 4.13. Irregularities in the correspondence between Persian letters and sounds: the letter /alef/ = ˌ, representing six vowels

/ahmad/ احمد /a/ (Name)
/emtehân/ امتحان /e/ (Exam)
/omid/ امید /o/ (Name)
/oo/ او /u/ (He/She)
/irân/ ایران /i/ (Name)
/âb/ آب /â/ (Water)

An additional character is used to represent the doubling of a letter. In some cases, this is vital to ensure understanding as, if the repetition if not included, the meaning of the word will change (see Figure 4.14). In Persian, as well as in Arabic, the character ˌ is used instead of duplicating the letter itself.
A final special feature of the Persian language is an extra vowel, called /ezâfeh/, which plays an important grammatical role in the language, but which is never shown in the written form. In written sentences where this extra vowel needs to be included, the understanding of the meaning of the sentence needs to be inferred from the context (see Figure 4.15). In this example, the extra vowel is in the second sentence (first translated word ‘Other’), embedded within the pronunciation of م The experienced reader should be able to identify the correct pronunciation and meaning from the text around the sentence.

Figure 4.15. Comparison of sentences which are the same apart from the unwritten grammatical constraint

مردم دیگر این کار را نمی‌کنند

The people will not do this anymore.

مردم دیگر این کار را نمی‌کنند

Other people do not do this.
Overall, the specific features of the Persian language mean that although its orthography is relatively transparent, particularly in the form used with a beginning reader, there are difficulties for the learner that may lead to differences from those found in English language studies of literacy acquisition and reading/spelling difficulties. The initial learning of fully marker text may lead to features of acquisition consistent with relatively transparent orthographies (such as German, Italian or Hungarian). However, the experience of text that does not contain short vowel markers may lead to similar acquisition features as those found with less transparent orthographies (such as English or French). The additional problems of differences between language and script (i.e., the Persian language using a form of the Arabic script designed for a different language) may lead to additional difficulties for grapheme-phoneme translation processes and produce findings less consistent with those predicted by studies of transparent orthographies, although research is necessary to determine these potential differences.

4.2 Method of teaching to read and write in Iranian school

4.2.1 Background

Iranian children without any formal educational program attend school at the age of six. This is after a screening test for diagnosing severe speech, hearing, auditory and visual disorders has been carried out. An intelligence evaluation is also carried out in some cases, although it is not as standard. Each academic year starts from the 23rd of September and continues through till the 1st of June the following year. A child over the age of six can go straight to grade 1. The new Iranian year in English months would start on the 21st of March. Therefore any child born between the 21st of March and the 22nd of September can go to school after the age of six. Even though most of the children can go to school after the age of six, certain
circumstances cause some children to start their education 12 months later than all others (e.g. children born on the 23rd of September 1998 can go to school with children born on the 22nd of September 1999).

Since there is a social class difference between the big cities and the rather small villages, statistically, most children live in smaller cities and villages. It can quite easily be said that most children without any educational background go to grade one. Even though in the last two decades, development of mass media has expanded vastly (e.g. T.V., radio) and has had a positive effect on the mental development and preparation of children for entrance to school. However, these improvements have only made progress in the larger cities. It is also possible for children to benefit from preparatory classes before going to grade 1. These classes are either private or are specific for government staff and potentially lead to cultural, social, economical, linguistic and cognitive ability difference in the main society in which the research has been carried out (Tehran).

The literacy education programme for all the children in this society follows a prescribed format, with all of the children in grade 1 having preparatory training in the 1st month of the academic year. The format is described in The manual for teaching reading and writing in grade one which is based on the book written by Jahanshahi and Siyahi (1989), and also a manual prepared for second year by the Ministry of Education for all the teachers all over Iran (Saffar poor and Moghadas , 1998), and the following outlines the details in this manual.

In the first days of primary school, new students become familiar with the class atmosphere and also with their fellow students, and the teacher becomes familiar with the moods and abilities of the students. The visual and auditory perception, ability of expression,
comprehension and reasoning is worked on with the aid of specific action pictures. During this period (one month) all students, in turn, talk about the pictured stories (these stories are sequenced from right to left by number because of the Persian script which is written from right to left) and become prepared for concept perception through visual or picture reading. During the picture discussion any articulation or grammar problems will be clear to the teacher. If the problem is simple, the teacher will help them to correct it; however, in very rare cases the problem may be severe and so is reported to the therapists or other specialists.

4.2.2 Important activities in preparatory periods

The most important activities during the preparatory period for all of the students are briefly shown below:

- Drawing and copying shapes that look like letters to establish writing skills.
- Teaching concepts of basic mathematics.
- Teaching language concepts; e.g., colours, jobs, seasons of the year, fruits, animals, etc.
- Correction of articulation and grammar difficulties.
- Increasing abilities of analysis and reasoning in accordance with their mental age.
- Phonological awareness, including:
  - Auditory discrimination, of initial, medial, and final phoneme
  - Word segmentation and naming the phonemes of each word
- Auditory training.

Based on characteristics of the Persian language, particularly the occurrence of phonemes in words and their relative difficulty of pronunciation, phonemes are classified as in Figure 4.16.
Figure 4.16. Categorization of phonemes for auditory discrimination tasks

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>/s/, /s/', /x/', /r/</td>
</tr>
<tr>
<td>B</td>
<td>/z/', /l/', /n/', /v/', /h/', /p/</td>
</tr>
<tr>
<td>C</td>
<td>/e/', /r/', /u/', /dz/', /t/, /o/</td>
</tr>
<tr>
<td>D</td>
<td>/k/', /b/', /i/', /m/', /q/', /f/</td>
</tr>
<tr>
<td>E</td>
<td>/a/, /o/, /â/, /d/, /ê/, /g/</td>
</tr>
</tbody>
</table>

Phonological awareness skills are taught by requiring the child to divide words into syllables and then sounds that form the syllable (phonemes). For example, a word such as /kârevânsarâ/ (which means hotel) can be segmented into the syllables: 
/kâ/, /rel/, /vân/, /sal/, /râ/ 

Each syllable should be prolonged and the phonemes of each syllable must be counted:

/k/ + /â/, /r/ + /e/, /v/ + /â/ + /n/, /s/ + /a/, /r/ + /â/ 

2 2 3 2 2

Both vocalization and hand position is used to support production of the word parts and counting. In this case, the successful student should have been able to identify the 11 phonemes in this word.

It should be mentioned that exercises for learning how to segment words into syllables and sounds start with one-syllable words like /pât/ (foot), or /mu/ (hair), and finishes with
multi-syllable words like /kârevânsarâ/ (hotel). Such phonological segmentation methods are used to support the student's ability to segment words in textbooks. This method is also advantageous in that any difficulty in the student's articulation will be detected and corrected prior to reading and writing. At the end of this period (one month of preparatory), most students will be deemed to have readiness skills for reading and writing.

4.2.3 Method of teaching

Methods of teaching reading and writing in the Iranian educational system involve a combination of techniques, leading to a system that has specific differences from the whole-word versus phonic methods used in English language schools. The teaching methods used are based on the alphabetic teaching method, and incorporate the teaching of sound-letter correspondences. An example of a common teaching protocol is provided for illustrative purposes.

First of all, the word /âb/ = water will be repeated many times for students. Then a picture of a glass with water in it will be shown to the students, and the teacher asks the students to say /âb/ many times and to segment /âb/. So, after some discussion for students, the teacher says: I'm going to write /âb/ for you. The teacher simultaneously, while writing /âb/ on the board, prolongs the sounds of the word /âb/. After writing /âb/ on the board from right to left, the teacher many times loudly reads the word /âb/ for the student. Then the teacher writes the first letter of /âb/ (i.e. /â/) separate from the second letter (i.e. /b/) and ask the students to repeat the letter /â/ and says, 'if the letter is at the beginning of a word it will be written /â/ otherwise it will be written /b/ like باد = د = wind (for phonetic transcription, /â/ = /â/ is written /â/ as in bâd = wind
and $\ddot{a}b = $ water irrespective of position; however in normal handwriting the mark above the line is not used in all positions within words). After some exercises, the teacher says the second letter of /$\ddot{a}b$/ i.e. /$\ddot{b}$/ = /$b$/ should be written with capital /$\ddot{b}$/ = /$b$/ , but in some other positions like in initial or medial, the letter /$\ddot{b}$/ = /$b$/ , will be small like /$b\ddot{b}a$/ , $\ddot{b}a\ddot{b}$ = father or /$b\ddot{a}d$/ , $\ddot{b}a\ddot{d}$ = wind.

In the first stage, the student reads the word as a whole word, and understands its meaning and can name its letters. In the second stage, by changing the position of the letters, new words are made such as ...

/$\ddot{a}b$/ → /$b\ddot{a}$/ = with /$b\ddot{a}$/ + /$b\ddot{a}$/ = $b\ddot{a}\ddot{a}$ , father $\ddot{b}a\ddot{b}$ . In the third stage, the letter of /$d$/ = $d$ in a word like $d\ddot{a}d$ , $d\ddot{a}d$ = gave, is taught. Then the teacher combines these three words and makes a meaningful sentence: $\ddot{b}a\ddot{a}d$ = daddy gave water.

In this manner, some other letters are added to the former letters, but each new letter is a target letter for the students and they should try to learn it. In other words each new letter is added to formerly learned letters. In this way, during nine months (one educational year), all of the letters of the alphabet are taught to the student. The order of teaching is presented in Figure 4.17.
Figure 4.17. Order of teaching of the letters of the Persian script

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>a</td>
<td>b</td>
<td>n</td>
<td>d</td>
</tr>
<tr>
<td>T</td>
<td>i</td>
<td>i</td>
<td>z</td>
</tr>
<tr>
<td>k</td>
<td>p</td>
<td>e</td>
<td>m</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>a</td>
<td>m</td>
<td>s</td>
<td>t</td>
</tr>
<tr>
<td>h</td>
<td>e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>z</td>
<td>z</td>
<td>z</td>
<td>z</td>
</tr>
<tr>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>H</td>
<td>SH</td>
</tr>
</tbody>
</table>

The table shows the order of teaching the letters of the Persian script with their corresponding names and positions.
As discussed in the last section, there are no specific written symbols for the short vowels, with diacritic marks being used in early grade textbooks, allowing new words to be experienced with short vowels thereby aiding the learning of pronunciation. Once learning has occurred, and words are presented without short vowels, the student is expected to derive the correct pronunciation of the word through trial and error, as well as vocabulary knowledge and an understanding of sentence structure. Therefore, grammatical and contextual information, in addition to a well developed sight vocabulary, become very important for correct pronunciation following the initial grade years of beginning reading.
One of the advantages of combining whole word recognition with phonological decoding techniques in educational practice is that the students should become familiar with individual letters as well as words, by experiencing them many times in words and sentences. After some practice, the students should be able to read the words without any doubt and hesitation, leading to increases in the rate of their reading. Although when reading unfamiliar passages, problems may be encountered, leading to a decrease in the rate of reading.

4.2.4 Common errors in reading

The features of the language and orthography discussed above predict that reading should be relatively easier than dictation writing. Therefore, as the student becomes familiar with the alphabet, they are able to read many words. However, there are some common mistakes in their reading at early stages (Majd Far, 1998). For example:

1) Errors may occur if the student is expected to read new words presented without diacritics.

2) Words that look like one another may be confused (although with practice this problem can be overcome), such as ...

/tut/ توت and /tup/ توب

/asb/ اسب and /ast/ است
3) Even though the sentence structure may allow the student to guess the correct verb inflection, some weaknesses in their grammar can cause them to have some difficulties in pronunciation.

4.2.5 Writing activities

After the preparatory period, reading simultaneously starts with writing drills. Initially, the teacher starts by getting the child to move their pencils in different directions, to support the learning of pencil grip and hand/arm movements. After reading and learning each new lesson, all of the students should do some writing drills from the new text, and then, one dictation writing from this new lesson. Since, in early stages, there are some consistencies between phonemes and graphemes, dictation writing is not difficult. However, when learning those letters that have similar sounds, problems may be encountered. For example, if a sound is represented by more than one grapheme, then the student may use the first grapheme that they has learned rather than the correct letter for the word (see figure 4.19).

Figure 4.19. Example of words that contain different letters but the same sound

/ezterâb/ ازتراب (incorrect)

/ezterâb/ اضطراب (correct)

(note: the first word does not have any meaning in Persian)

4.2.6 Common errors in dictation writing

The examples below are presented as amongst the most common mistakes for grade one and grade two students in dictation writing. In addition to these difficulties, there are some other difficulties stated by Saffarpoor & Moghadas (1998), which will be discussed below.
1) Decreasing or increasing of some symbols in dictation writing e.g.:

/s/ س (correct), پس (incorrect)

2) Decreasing or increasing duplication in dictation writing, e.g.:

/serr/ سر = secret, in contrast with /ser/ سر = anesthesia

(pay attention to the symbol over letter /r/ ژ in the word /serr/ سر = secret)

3) Decreasing or increasing of dots for some letters in dictation writing, e.g.:

/basteh/ بسته and /pesteh/ پسته (Note: pay attention to the dots)

4) Attachment or detachment of one letter to other letters, e.g.:

پنوسیم (correct), پنوسیم (incorrect)

5) Attachment of /mi/ می with verbs, e.g.:

I go = می روم (correct), می روم (incorrect)

6) Separation of small /b/ ب from verbs, e.g.:

پروم (correct), پروم (incorrect)
7) Lack of possessive pronoun, e.g.:

/ xânejesabz / # /xanesabz/ , this symbol will be shown with ‘ء’ in writing :

خانه سبز (correct), خانه سبز (incorrect)

8) Increasing or decreasing of some letter in a word, e.g.:

/ nešasam / (correct), / nešasam / (incorrect)

9) Wrong writing, e.g.:

/zohr/ = noon = ظهر (correct), /zohr/ زهر (incorrect – not a Farsi word)

10) Colloquial writing, e.g.:

/difâl/ instead of / di vâr/ = wall

11) Lack of diacritic symbol, e.g.:

آدم (correct), ادم (incorrect)

12)

13) Increasing diacritic symbol, e.g.:

کشک (correct), کشک (incorrect)
14) Word omission: in which the child omits to write a dictated word, possibly due to carelessness if writing quickly, but sometimes due to the inability to spell the word.

15) Macrography (indicating that handwriting is bigger than standard size) or micrography (handwriting is smaller than standard size) may also be found amongst early learners and will need special attention and drill.

16) The direction of writing may also be a problem for some children – i.e, writing from left to right instead of right to left as is standard in Persian.

All of the above difficulties can be individual to a particular child and will need special attention.

4.3 Dyslexia awareness and assessment
There are five years of education at primary school in Iran. This is followed by secondary school, which consists of a further three academic years. High school comprises four more years, but in contrast to the previous years, the student studies subjects that are in the area of their interest. Children typically start attending school when they are 6 years old, although some schools take their students one year before for preparations for the primary school and hence such children would be aged 5 (similar to the system in England). Diagnosis of hearing, speech or visual problems would be possible via primary screening tests, which any children would have to through before going to school. Whether the child starts in a preparatory year or not, all students in first year of primary school experience the same
instructions and currently there is no effective way to diagnose dyslexia before finishing first grade.

There is a problem with awareness of dyslexia in Iran. A large percentage of Iranian people consider dyslexic children as mentally retarded and there is a lack of explicit knowledge of literacy problems. Giving the current definitions of dyslexia, the lack of clear criteria to evaluate children with learning difficulties makes diagnosis problematic. In spite of this, any child who shows difficulty in learning to reading letters, words and context, as well as having difficulties in spelling Persian letters and words properly, may be labeled as a dyslexic pupil. In the last two decades, the increase in the amount of research, as well as the large number of psychologist and speech therapists graduates has helped in the raising of public awareness. However, further work on the development of appropriate psychometric methods and speech therapy examinations should support the assessment of learning difficulties in the early literacy learning population.

Currently, in Tehran (the capital of Iran), one to three percent of the pupils between 8-11 years old have been recognized as dyslexic. However, some reported research suggests that this amount increases to 5.5 percent if poor and slow readers are counted as dyslexics as well (Danekar, 1993).

Primary school teacher and speech therapists in the major cities usually perform reading and writing assessments. Although there is no standard Persian reading and writing test, informal measures have been used. The initial intensive phonological training course in the beginning of the first grade enables teachers to recognize students who have severe to mild problems in
In the following months, if the child shows difficulty in reading and writing, the teachers can pay special attention to these children as potential dyslexic students.

Since 1970, the Iranian education system has included specially trained teachers for those children who are mentally retarded. In addition, since 1981, the advanced studies and sciences ministry has established a four years program to train special teachers. Those graduating from this programme should have a high level of knowledge about psychology, psychometrics, behavior therapy, and speech and language sciences. This training should enabled teachers to diagnose earlier and intervene on time.

Recently two supportive educational centers have been established in Tehran for those children who are studying in ordinary schools and suffering from dyslexia. These provide dyslexic children with two to three extra lessons per week to allow them the opportunity to keep up with the rest of children. Although there are only a few private special schools for dyslexic children, their programs cover all areas: the school programs itself and speech and behavior therapy all at the same time. There are not enough supporting programs in secondary and high school levels, and, unfortunately, dyslexies often have great difficulty when it comes to further education.
Chapter 5

Developing of measures

5.1 Background

A series of test measures were developed for this programme of research. These were based on the models/theories outlined in chapters 1 to 3, with reference to the context discussed in chapter 4. The areas targeted by the test materials assessed visual and auditory processing, rapid naming, phonological awareness and working memory functioning, as well as single letter/word naming, text reading accuracy, rate and comprehension, and word and text spelling ability. These materials were developed, piloted with trained testers in order to ensure that materials were usable by professionals and researchers, and then, following appropriate modifications where necessary, used for data collection as described in the following chapters. The basic materials were developed to assess early literacy, and therefore were most appropriate for grades 1 and 2. Subsequent materials were included to allow testing of older children. The present chapter describes the basic test materials, with modifications described in the following chapters. The aim of this chapter is to provide the reader with some background to the materials used and a quick point of reference for the measures discussed in later sections of the thesis, as well as a source of measures for further use and development (the full test can be found in appendix 1).

5.2 Materials

5.2.1 General procedures

During the testing procedures, children were tested individually in a quiet room within their schools by six trained speech therapists who had been given detailed instructions and practice in administration of the measures. Record sheets were used to code answers and verbal reports were recorded on tape to allow checking of the test procedures. Most of the measures
were presented to the children in the order described below, as concepts in one test should allow understanding in a subsequent task. Practice trials were included to ensure that the child understood the task requirement. Literacy-based materials were taken from grades 1 and 2 reading textbooks used in Iranian primary schools. To developing these measures, a number of reading and spelling tests were reviewed, including:

1. The Boder Test of Reading-Spelling Patterns (Boder & Jarrico, 1982).
2. Star Track Reading and Spelling test. (Beadle & Hampshire, 1996).
6. Spar Spelling and Reading Test (Young 1987).
8. Graded Word Reading Test (Bridie, 1985).

5.2.2 Visual discrimination

Measures in this section of the test were divided into four parts. Although these measures were not included in the tests used in the main part of the thesis, due to time constraints and potential ceiling effects produced by older children, they are described to show the types of measures developed for the testing programme.

Part 1- Letter matching

The child was required to match a given letter with one of the four alternative letters. For example, the target letter ب matches only one of the four alternatives: ب ت ف. Following practice, there were ten trials in this part of the test.
Part 2- Identifying letters from the words

This task was similar to the first part, but this time the child was required to identify a word that contained a target letter; for example, the target letter ج appears in the word كاج. Three written words were presented, only one of which contained the target letter. There were ten trials in this part of the test.

Part 3- Word matching

In this task, the child was tested on their ability to match a target word with one of four alternative words. For example, the target word نبneeds to be identified amongst the words: توت نوب سوت سوب. There were six trials in this part of the test.

Part 4- Auditory-visual matching

In this part of the test, the child was examined on the ability to match visual and auditory cues. A particular target sound was articulated to the child (e.g., /ج/ /dz/) and they were asked to identify the letter amongst a string of visually presented letters. Only one of the letters matched the target sound (e.g., ج /dz/ م / m/ ح / h/ ك /k/). There were four trials in this part of the test.

5.2.3 Auditory Discrimination

As with the above tasks, these measures were not used in the following chapters for the same reasons as above, and are reported here as evidence of the type of measures used in the development of the current work. There were four parts to this area of testing.
Part 1-A: Identifying sound in words
In this task, the child was expected to listen to the articulation of a target sound and then identify the same sound in one of five words read to him/her. For example, the sound /b/ (represented by \( \overline{b} \)) is found in /abr/ (meaning cloud). Three out of the five words articulated contain the target sound in either the initial, or middle or final position, and the other two words do not contain the target sound. Marks are awarded for each correct decision on each word read.

Part 1-B: Identifying sound in nonsense words
The same task was used except that five articulated nonsense words were read to the child, (e.g., "ب" /b/ in /mabr/ which has no meaning). Again marks were given for correct decisions on each nonsense word.

Part 2- Identifying word sounds
In this part of the test the child is expected to decide if a pair of words are identical or whether they rhyme. The child must repeat the words which they have heard, and then make their choice. E.g. /feel/ versus /zud/. There were ten trials in this part of the test.

Part 3- Matching words
A series of target words ranging between one to five syllables (e.g., /hayejjan/) is read aloud and the child is required to repeat each word correctly. Particular attention is devoted to the following possible errors made by the child: substitutions, omissions, distortions and pauses of more than four seconds. There were ten trials in this part of the test.
5.2.4 Rapid naming

This test was based on those used by Denckla & Rudel (1976), Wolf, Bally & Morris (1986), and Cronin & Carver (1998). This task is intended to measure the speed with which the child can name drawings of a horse, clock, car, apple and ball. Each picture is repeated ten times on the page, requiring the child to produce 50 naming responses (i.e., name the five pictures ten times each). The order of presentation of the drawings was randomly determined. The child was required to start with the item at the top right-hand side of the page and move to the left (as Persian is read from right to left), naming each picture as fast as possible, until they finished with the item at the bottom left-hand side of the page. A stop watch was used to measure the naming speed in seconds taken from the first naming response to the last. The times were then converted into the number of items named per minute.

5.2.5 Phonological awareness

The three phonological tasks were modeled on those developed by Rosener & Simon (1971), Manis & Custodio and Szczukulski (1993), Catts & Vartianen (1993) and North, & Parker (1994).

Part 1- Phoneme blending

This part indicates if the child has the ability to blend phonemes. For example, the child is presented with /b/ + /u/ and then asked what word does this produce? The correct answer is /bu/ meaning smell. There are ten trials in this part of the test with the level of difficulty varying by increasing the number of phonemes from two to five.
Part 2- Phoneme deletion

In this part of the test the child’s ability to recognise a deleted phoneme from a word is tested. The child hears a word like /sab/ meaning night, and is asked what remains of the word if we delete /s/. The answer is /ab/. Similar to part 1, ten trials were varied in their level of difficulty by increasing the number of phonemes per word from those with two phonemes to words consisting of seven phonemes.

Part 3- Phoneme segmentation

In this section of the test the child is presented verbally with a word and is asked to segment it into the phonemes comprising that word. For example, the word /mesvak/ meaning toothbrush, is presented to the child and he/she is required to name each individual phoneme: i.e., /m/ /e/ /s/ /v/ /a/ /k/. For every correct phoneme the child receives one score, e.g., if a child performs correctly on /mesvak/ he/she will receive six points. This is because the word consists of five printed letter phonemes plus the short diacritic /e/. There were ten trials in this part of the test.

5.2.6 Working memory

These tasks were based on those reported and used in Baddeley (1993). The tasks were chosen to assess the child’s working memory for letters, words and sentences. Visually and verbally presented materials were used across the different measures, with verbal responses being required of the children. The combined measures provided an assessment of the child’s
ability to retain linguistic material for a short period of time and repeat this material in a particular order.

Part 1 - Verbal memory for sounds

Letters were read to the child, who was asked to repeat them in the order of presentation. For example, if the sounds /c/ , /f/ , and /k/ are presented and the child has to repeat /Ô/ , /f/ and /k/. The number of items repeated in the last correct trial was considered equivalent to the child's memory span. After the child has completed this part of the test the similar items were read aloud, and this time the child was required to repeat the letter sounds in reverse order.

Part 2 - Verbal memory for words

In this part of the test, the child is presented verbally with a sequence of non-rhyming words which they repeat in the order of presentation. Trials contained sequences of two words, increasing up to seven word sequences. There were three trials per sequence length. As before, the number of words within a sequence in the last correct trial was equivalent to the memory span. If the child did not repeat correctly the three trials in a particular sequence length, the test was terminated.
Part 3- Verbal memory for sentences

In this part of the test a sentence is read to the child and he/she is asked to repeat the sentence (e.g., /ali dočarxe darad/ meaning Ali has a bicycle). The trials began with the presentation of a sentence consisting of three words and increased to the presentation of a sentence with fifteen words. To receive the total maximum score for each sentence, the child must repeat all the words correctly. The total maximum score in each trial depended on the number of words in the sentence: e.g., trial number five contained eleven words; therefore, the child received eleven points for a correct repetition. If the experimenter repeated the sentence twice and the child would not repeat the sentence correctly either time, the test was terminated.

Part 4- Memory for pictures

In this part of the test, pictures were presented to the child and he/she was asked to recall them in the order of presentation. For example, the child might be presented with pictures of a flower and a car, then after the pictures were out of view, the child would be expected to say ‘flower, car’. There were six trials in this section of the test with the number of pictures increasing in each trial from two to seven. The number of pictures in the last correct trial was equivalent to the memory span.

Part 5- Memory for letters

The child was presented with printed letters from the alphabet (e.g., /t/ and /k/) and, once the visual stimuli were removed, the child was required to say the letters in the order of presentation. The trial ranges from two to seven letters, with scoring being the same as in the pictures task.
5.2.7 Oral reading

This section consisted of two parts.

Part 1- Letter naming
The child was presented with the letters of the alphabet in two different lists and was asked to name each letter. In one list all the letters were presented in their isolated form. In the second list, letters were presented as they would appear in written Persian text; i.e., the varying forms of letters found in words. The child was required to name each letter correctly. If the child took longer than four seconds to name a letter, then the experimenter named the letter and no score was given. The maximum score for this task was 57.

Part 2- Reading words
Two lists of words were presented to the child for naming. The first list contained twenty words, each of which included the appropriate diacritic marks. The second list comprised twenty words without diacritics. Figure 5.1 gives examples of a Persian word that incorporates a written vowel and a word that can be presented with and without a diacritic mark.
Figure 5.1: Example of a word with a vowel as part of its normal written form, and a word which can be written with or without a diacritic mark.

<table>
<thead>
<tr>
<th>Persian Spelling</th>
<th>Vowel letters</th>
<th>With diacritic</th>
<th>No diacritic</th>
</tr>
</thead>
<tbody>
<tr>
<td>كار</td>
<td>/kar/</td>
<td>/mord/</td>
<td>/mard/</td>
</tr>
<tr>
<td>مرد</td>
<td>/mord/</td>
<td>/merd/</td>
<td>man, died, nonsense</td>
</tr>
<tr>
<td>Translation</td>
<td>work</td>
<td>Died</td>
<td></td>
</tr>
</tbody>
</table>

In each list there were 10 words taken from grade 1 and 2 textbooks, which should be familiar to all grade 2 children, and 10 words that were taken from other works and, therefore, would be less likely to be familiar to grade 1 and 2 children.

5.2.8 Text reading accuracy and comprehension

This section of the test contained six reading passages. The first and second passages were modified versions of prose taken from the children's grade 1 textbooks and, hence, contained words that should be familiar to all the children assessed (the passages were modified from their appearance in the children's textbooks to avoid the child being able to read them off by
heart). A third passage was taken from a book not used as part of the children's schooling, but which had been written at a level suitable for grade one children.

The fourth and fifth passages were from the children's grade 2 textbooks. Again, the structure of the sentences was changed to avoid over-familiarity with the passages. The sixth passage was taken from a science book not used in the schools. This was a difficult passage for the children due to the use of non-familiar words and sentences, and was included to ensure that highly able readers could be distinguished in the work.

The task required the child to read each passage aloud. Once completed, the child is asked a series of questions about the passage. The number of questions increased from three to six per passage. For example, if the passage comprised:

'Amin wakes up early in the morning. He cleans his face and hands with water and soap and brushes his teeth. Amin also brushes his teeth after each meal and cleans his toothbrush so as to take care of it.'

The following questions would be asked of the child:

'Why does Amin clean his tooth brush?'

'How often does Amin brush his teeth?'

'If there is no soap what else does Amin use for cleaning his face?'

The tester recorded the number of words read correctly in the passage, the time taken to read the passage and the number of comprehension questions answered correctly. The time taken to read the passage was converted into the number of words read per minute to provide an estimate of rate of reading. The number of words in each passage and number of comprehension questions per passage were: 44, 3; 58, 4; 89, 5; 100, 5; 103, 6; 112, 6. If the
child produced more than 10 reading errors in each passage, or paused for more than 4 seconds on 10 words, they were not given the next passage.

5.2.9 Dictation spelling

There were three parts to this test.

Part 1- Letter spelling

Ten letters were dictated to the child and the child was given a mark for each correctly printed letter.

Part 2- Word spelling

Thirty individual words were dictated to the child and he/she was required to write them with their correct spelling. The test started with one syllable words, with items gradually increasing to five syllable words. Half of the words were taken from grade 1 textbooks and half were from grade 2 textbooks.

Part 3- Text dictation

In this section of the test, two passages were read to the child, who was expected to write down the text using correct spellings of words. The first passage consisted of 45 words appropriate for grade 1 children. The second passage was more appropriate for grade 2 children and consisted of 50 words. Each passage was scored as the number of words in the passage minus the number of mistakes taken as incorrect spellings, substitutions of letters, omission of letters and words.
Chapter 6

Literacy development in Persian language speakers

6.1 Introduction

There is an increasing amount of empirical evidence that show differences in orthographic structure of languages have an influence on the development of literacy and other metacognitive skills (see previous literature background chapters). Children learning to read in Persian (Farsi) are faced with a fairly consistent (fully marked) orthography and correspondences between spoken and written words are primarily taught by phonics-oriented teaching methods. By the end of grade 1, most children are able to use grapheme-to-phoneme translation procedures to decode known and unknown words (with diacritics) correctly. However, as discussed in the previous chapters, the grapheme-phoneme correspondence of the Persian writing system is complicated due to the borrowed nature of the alphabet; i.e., an alphabet developed to represent Arabic. Only sixteen of the characters represent one single phoneme in each case. In the rest of the cases, some sort of discrepancy exists between the phoneme and its representing grapheme. For example, a single phoneme may be represented by four different characters. In Arabic, each character would have its own phoneme; however, because these phonemes don’t exist in the Persian language, those graphemes are used to represent that Persian phoneme that is the most similar to the original Arabic phoneme. These irregularities, together with the experience of unmarked and therefore relatively opaque text, may make the acquisition of literacy skills amongst Iranian children more problematic than for those experiencing a more regularly transparent orthography and may lead to acquisition difficulties more akin to those found with less transparent orthographies, such as English.
The present study, therefore, investigated literacy levels of children learning the Persian orthography over the initial grades in Iranian schools. It also assessed skills that may be primarily related to literacy acquisition to determine if these skills show similar improvements over the initial grade years consistent with an association between literacy and these potential predictors of literacy levels. Based on the literature reviewed in the previous chapters of this thesis, phonological processing abilities would be predicted to be a major determinant of learning to read. Therefore, these processes were the focus of the literacy-related measures included in this study. Three types of phonological abilities can be distinguished: phonological awareness, phonological coding in short-term memory and the retrieval of phonological codes from long-term memory (rapid naming). Phonological awareness at the level of phonemes (phonemic awareness) is considered especially important for early reading acquisition. In the first months of formal instruction (in Iran) the focus is on the correspondence of letters to sounds and the detection letters and sounds in written and spoken words respectively. Consequently, a relationship between phonological awareness and the development of reading acquisition is likely to be observed. One of the main aims of this study was to test this hypothesis in the Persian orthography. However, other areas of processing have been found to be associated with literacy skills, particularly when a more transparent orthography is learnt. Hence, measures of verbal short-term memory and rapid naming were included in the study as these are the areas that may be associated with literacy levels in the more transparent form of the Persian orthography most often experienced by the beginning literacy learner.

Development of reading and spelling and its relation to different cognitive skills was investigated in a cross-sectional study with Persian-speaking subjects. Its prime aim was to establish what cognitive skills and processes constitute constraints of reading and spelling,
and whether these are consistent with predictions derived from more or less transparent orthographies.

6.2 Part A: Grades one to five

6.2.1 Method

6.2.1.1 Participants

In the first part of this study, 140 children from grades 1 and 5 were selected from a number of schools across Tehran in order to ensure that the sample represented a variety of social/educational backgrounds. All schools in Tehran, regardless of geographical location, use the same curriculum, with all textbooks being exactly the same across schools. Children were selected, following parental and teacher consent, on the basis of information from school records that indicated that these children presented no evidence of literacy learning problems. Roughly, half of these children were male and the other half were female (see Table 6.1). The native language of all the children tested was Farsi (Persian), and interviews suggested that they had no knowledge of any other language.

Table 6.1. Ratio of female (f) to male (m) children of normal pupils from grades 1 - 5

<table>
<thead>
<tr>
<th>Normal pupils</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female : male ratio</td>
<td>15 f : 15 m</td>
<td>15 f : 15 m</td>
<td>14 f : 12 m</td>
<td>13 f : 15 m</td>
<td>13 f : 13 m</td>
</tr>
<tr>
<td>Mean age in months</td>
<td>85.13</td>
<td>97.80</td>
<td>115.65</td>
<td>126.03</td>
<td>135.92</td>
</tr>
</tbody>
</table>
6.2.1.2 Materials and procedure

The measures used in this study assessed phonological awareness, rapid naming, short-term memory, reading and spelling – see the previous chapter for details of these test measures. Phonological awareness was measured by task of phoneme blending, phoneme deletion and phoneme segmentation. Rapid naming was measured by a speeded digit naming task. Short-term memory was assessed by the verbally presented letter sounds, words and sentences tasks, as well as the visually presented pictures and letters tasks. Word reading was measured by the isolated word tasks, with lists comprising words with or without diacritics. Text reading accuracy, comprehension and rate were measured by giving the child the first, third and fifth passages from the test battery (see previous chapter). Spelling was assessed by the isolated word task and by requiring the child to write down the second passage to dictation.

All children were examined individually in a quiet room, away from distractions and other children. The full testing procedure took approximately one hour and was performed over several days to avoid fatigue. Test administrators were trained researchers/therapists who were familiar with the test materials and procedures.

6.2.2 Results

6.2.2.1 Descriptive statistics and comparisons across grades

Means and standard deviations for each of the phonological and memory measures used in the study are presented in Table 6.2, together with analyses of variance, comparing grade levels, followed by post-hoc (Tukey) pairwise comparisons.

For the phonological awareness tasks, scores are presented as the percentage of items correct. These results suggest that, for blending and segmentation tasks, the majority of children are
scoring at or about the maximum for these tests. This may not be surprising as these tasks were developed with the purpose of screening the dyslexic student from the normal reader, rather than identifying skills among those with normal literacy acquisition. However, phoneme deletion, which appears to be the most difficult phonological task, does show an effect of grade, suggesting that this area of phonological skill may still be developing over these initial grades.

Rapid naming rate indicated some evidence of improved naming speeds across the grades; however, there seems to be only a gradual improvement over these early years and it may be that other naming speed measures would better represent improvements with grade levels. (In the second part of this chapter, digit naming speed will be assessed.)

The memory results show the scores produced on the different tasks. Generally, these data showed evidence for improvements with grade level. The exceptions were the word task, which showed only a small non-significant change over grades and the forward letter sound task, which showed a highly variable performance with grade (i.e., grade 5 children performed quite poorly on this task compared to other grades).

Figures 6.1 to 6.4 provide graphical representations of the main findings, with data divided across male and female participants in the different grades. Note that these graphs suggest that, in general, males were performing worse on the measures than females. Although not the main aim of the data collection, these differences meant that to confirm any effects across grades in both boys and girls, two-way analyses of variance were also performed on the measures, with grade as one factor and sex as the other. These indicated non-significant interactions for all measures (F<1 in the majority of cases and p>.15 in the rest) except the
memory for sounds in reverse measure (F=2.93, p=.025), and although this may suggest that
effect of grade was smaller amongst male participants than female participants, simple-main
effects of grade were significant with both males and females (both p<.05). Although
potentially interesting, such an individual effect amongst a large number of analyses requires
further research to confirm before attempting an explanation. Indeed, the only main effect of
sex in these analyses was for the rapid naming task (F=4.31, p=.04). Overall, therefore, these
findings suggest a general trend for improvements across grades across male and female
participants.
Table 6.2. Means, standard deviations (in parentheses) and the results of anova and post-hoc tests on the scores of 140 grade 1 to 5 pupils on the measures of phonological awareness and rapid naming.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>F</th>
<th>p</th>
<th>Post hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Naming rate</td>
<td>61.20</td>
<td>63.05</td>
<td>64.67</td>
<td>67.32</td>
<td>72.13</td>
<td>2.64</td>
<td>.03</td>
<td>1&lt;5</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>65.33</td>
<td>59.66</td>
<td>76.25</td>
<td>77.00</td>
<td>81.15</td>
<td>4.96</td>
<td>.001</td>
<td>1&lt;5</td>
</tr>
<tr>
<td>Phoneme Blending</td>
<td>97.00</td>
<td>90.66</td>
<td>96.66</td>
<td>94.28</td>
<td>93.07</td>
<td>2.25</td>
<td>.06</td>
<td>Not sig</td>
</tr>
<tr>
<td></td>
<td>(5.34)</td>
<td>(11.42)</td>
<td>(7.01)</td>
<td>(9.78)</td>
<td>(11.58)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>94.65</td>
<td>91.39</td>
<td>96.79</td>
<td>95.47</td>
<td>95.17</td>
<td>1.06</td>
<td>.376</td>
<td>Not sig</td>
</tr>
<tr>
<td></td>
<td>(10.74)</td>
<td>(15.96)</td>
<td>(4.73)</td>
<td>(7.07)</td>
<td>(6.38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verb-memory: Sounds</td>
<td>4.36</td>
<td>4.00</td>
<td>4.52</td>
<td>4.76</td>
<td>4.15</td>
<td>2.43</td>
<td>.05</td>
<td>2&lt;4</td>
</tr>
<tr>
<td></td>
<td>(.80)</td>
<td>(.78)</td>
<td>(1.19)</td>
<td>(1.04)</td>
<td>(.96)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verb-memory: Reverse sounds</td>
<td>2.33</td>
<td>2.50</td>
<td>2.65</td>
<td>2.86</td>
<td>3.11</td>
<td>4.56</td>
<td>.002</td>
<td>1,2&lt;5</td>
</tr>
<tr>
<td></td>
<td>(.66)</td>
<td>(.62)</td>
<td>(.58)</td>
<td>(.63)</td>
<td>(.83)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verb-memory: Words</td>
<td>4.30</td>
<td>4.43</td>
<td>4.44</td>
<td>4.52</td>
<td>4.50</td>
<td>.38</td>
<td>.818</td>
<td>Not sig</td>
</tr>
<tr>
<td></td>
<td>(.74)</td>
<td>(.67)</td>
<td>(.65)</td>
<td>(.98)</td>
<td>(.58)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verb-memory: Sentences</td>
<td>10.30</td>
<td>9.60</td>
<td>13.26</td>
<td>13.60</td>
<td>13.76</td>
<td>49.56</td>
<td>.001</td>
<td>1,2&lt;3,4,5</td>
</tr>
<tr>
<td></td>
<td>(1.72)</td>
<td>(1.77)</td>
<td>(1.37)</td>
<td>(1.49)</td>
<td>(.99)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vis-memory: Pictures</td>
<td>3.86</td>
<td>4.1</td>
<td>4.75</td>
<td>4.85</td>
<td>4.80</td>
<td>7.22</td>
<td>.001</td>
<td>1&lt;3,4,5</td>
</tr>
<tr>
<td></td>
<td>(.86)</td>
<td>(.71)</td>
<td>(1.03)</td>
<td>(.93)</td>
<td>(.89)</td>
<td></td>
<td></td>
<td>2&lt;4,5</td>
</tr>
<tr>
<td>Vis-memory: Letters</td>
<td>4.2</td>
<td>4.33</td>
<td>5.04</td>
<td>5</td>
<td>4.96</td>
<td>4.6</td>
<td>.002</td>
<td>1&lt;3,4,5</td>
</tr>
<tr>
<td></td>
<td>(.80)</td>
<td>(1.06)</td>
<td>(1.16)</td>
<td>(1)</td>
<td>(.87)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Figure 6.1.** Graphical presentation of the level of performance of male and female students across grades 1-5

![Rapid naming for picture](chart1)

**Figure 6.2.** Graphical presentation of the level of performance of male and female students across grades 1-5

![Phoneme deletion](chart2)
Figures 6.3 and 6.4. Graphical presentation of the level of performance of male and female students across grades 1-5.

Tables 6.3 present the summary data for the literacy variables in the study. For all measures, except text reading rate, scores were converted to percentage correct to more easily represent the level of performance achieved. As it can be seen, most of the children obtained high scores in reading accuracy from an early stage. In terms of text reading accuracy, the scores could be attributed to the relative simplicity of the text or to the transparency of the Persian orthography, allowing the beginner readers to present higher accuracy in early stages of literacy. However, there was evidence of gains in text reading speed and comprehension across the grades and isolated word reading also showed evidence of grade effects. Reading words without diacritics (as would be expected) was more difficult for beginner readers.
However, a general improvement was seen in reading with and without diacritics, particularly between grades 1 and 3.

In terms of reading speed, scores suggest evidence of a general improvement across years, except for the third text, which shows a variable rate across the grades, possibly due to the unfamiliar content requiring time for high levels of comprehension to be achieved. The relationship between grade and reading rate may be due to the development of a sight vocabulary rather than phonological decoding, which most of these beginning readers seem to be using at a relatively early stage of learning; although phoneme deletion still shows evidence of improvements in phonological awareness skills over the five grades.

The results of the spelling measures show a similar trend to those found for reading, with grade 1 children performing significantly worse than the other grades on both spelling measures. Again, as with reading, there is a tendency for ceiling effects in text spelling, suggestive of these children being reasonable accurate in reading and spelling connected text.

Figures 6.5 to 6.8 provide examples of these literacy results across grades, with the figures divided for male and female students. Although the graphs suggest that male participants may be showing different effects compared to females, two-way analyses of variance performed to assess grade and sex effects indicated non-significant interactions for all measures (F<1 in the majority of cases and p>.10 in the rest) except the rate of reading text 3 (F=4.58, p=.002); although, even in this case, simple-main effects of grade were significant for both males and females (both p<.05). As with the interaction in the previous set of two-way Anovas, such an individual effect following a large number of analyses will require further research to confirm prior to attempting an explanation. Although males showed a trend for general weaker
performance than females, the only main effects of sex in these analyses were for reading accuracy of text 1 \( (F=5.27, p=.02) \), reading rate of text 1 \( (F=10.46, p=.002) \) and reading unmarked words \( (F=4.19, p=.04) \). Overall, therefore, these findings suggest a general trend for improvements across grades across male and female participants, but for some evidence of better performance amongst girls than boys.
Table 6.3. Means, standard deviations (in parentheses) and the results of anova and post-hoc tests on the scores of 140 grade 1 to 5 pupils on the literacy measures.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>F</th>
<th>p</th>
<th>Post hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marked word reading</td>
<td>81.66 (10.69)</td>
<td>91 (7.35)</td>
<td>95.64 (5.80)</td>
<td>95.0 (5.44)</td>
<td>95.84 (4.96)</td>
<td>19.64</td>
<td>&lt;.00</td>
<td>1&lt;2,3,4,5</td>
</tr>
<tr>
<td>Unmarked word reading</td>
<td>73.00 (15.40)</td>
<td>82.00 (9.71)</td>
<td>92.88 (8.05)</td>
<td>96.60 (4.52)</td>
<td>96.19 (4.71)</td>
<td>33.35</td>
<td>&lt;.00</td>
<td>1&lt;2,3,4,5</td>
</tr>
<tr>
<td>Accuracy: Text1</td>
<td>98.53 (2.36)</td>
<td>98.78 (3.46)</td>
<td>98.36 (2.74)</td>
<td>98.86 (1.80)</td>
<td>99.45 (4.52)</td>
<td>.47</td>
<td>.756</td>
<td>Not sig</td>
</tr>
<tr>
<td>Rate: Text1</td>
<td>73.59 (25.58)</td>
<td>106.35 (31.15)</td>
<td>107.69 (32.15)</td>
<td>119.65 (36.11)</td>
<td>126.19 (31.53)</td>
<td>12.02</td>
<td>&lt;.00</td>
<td>1&lt;2,3,4,5</td>
</tr>
<tr>
<td>Compression: Text1</td>
<td>66.10 (27.15)</td>
<td>79.44 (22.18)</td>
<td>86.10 (19.45)</td>
<td>90.47 (21.45)</td>
<td>93.90 (12.81)</td>
<td>7.301</td>
<td>&lt;.00</td>
<td>1&lt;3,4,5</td>
</tr>
<tr>
<td>Accuracy: Text3</td>
<td>94.73 (5.06)</td>
<td>97.33 (3.27)</td>
<td>95.54 (12.19)</td>
<td>99.20 (.97)</td>
<td>99.30 (.95)</td>
<td>3.22</td>
<td>.015</td>
<td>1&lt;5</td>
</tr>
<tr>
<td>Rate: Text3</td>
<td>51.33 (24.76)</td>
<td>79.57 (26.95)</td>
<td>67.84 (36.95)</td>
<td>54.75 (13.92)</td>
<td>49.07 (14.28)</td>
<td>7.56</td>
<td>&lt;.00</td>
<td>1,4,5&lt;2</td>
</tr>
<tr>
<td>Compression: Text3</td>
<td>60.10 (25.17)</td>
<td>69.33 (23.73)</td>
<td>87.91 (15.31)</td>
<td>92.69 (10.93)</td>
<td>93.28 (11.90)</td>
<td>16.08</td>
<td>&lt;.00</td>
<td>1,2&lt;3,4,5</td>
</tr>
<tr>
<td>Accuracy: Text5</td>
<td>94.74 (4.25)</td>
<td>96.14 (8.00)</td>
<td>97.68 (3.16)</td>
<td>99.19 (.88)</td>
<td>98.74 (1.23)</td>
<td>2.52</td>
<td>.045</td>
<td>none</td>
</tr>
<tr>
<td>Rate: Text5</td>
<td>55.35 (14.86)</td>
<td>74.44 (30.70)</td>
<td>83.36 (29.80)</td>
<td>98.17 (34.30)</td>
<td>109.28 (28.09)</td>
<td>6.76</td>
<td>&lt;.00</td>
<td>1,2&lt;4,5</td>
</tr>
<tr>
<td>Compression: Text5</td>
<td>58.33 (16.66)</td>
<td>70.23 (19.95)</td>
<td>88.11 (10.18)</td>
<td>91.10 (10.18)</td>
<td>85.39 (14.17)</td>
<td>10.21</td>
<td>&lt;.00</td>
<td>1,2&lt;3,4,5</td>
</tr>
<tr>
<td>Dictation Word</td>
<td>65.73 (17.59)</td>
<td>83.44 (14.75)</td>
<td>88.21 (8.10)</td>
<td>88.44 (7.57)</td>
<td>90.08 (8.57)</td>
<td>17.67</td>
<td>&lt;.00</td>
<td>1&lt;2,3,4,5</td>
</tr>
<tr>
<td>Dictation Text2</td>
<td>84.20 (8.31)</td>
<td>93.73 (17.96)</td>
<td>95.13 (4.92)</td>
<td>96.90 (3.75)</td>
<td>97.00 (4.20)</td>
<td>7.79</td>
<td>&lt;.00</td>
<td>1&lt;2,3,4,5</td>
</tr>
</tbody>
</table>
Figures 6.5 to 6.8. Graphical presentation of the level of performance of male and female students across grades 1-5
Table 6.4. Pearson correlations between age, grade and the measures in the study

<table>
<thead>
<tr>
<th>Variables</th>
<th>age</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid naming</td>
<td>.28*</td>
<td>.264*</td>
</tr>
<tr>
<td>Phoneme blending</td>
<td>-.049</td>
<td>-.07</td>
</tr>
<tr>
<td>Phoneme deletion</td>
<td>.369**</td>
<td>.317**</td>
</tr>
<tr>
<td>Phoneme segmentation</td>
<td>.090</td>
<td>.073</td>
</tr>
<tr>
<td>Verbal memory for sounds forward</td>
<td>.045</td>
<td>.041</td>
</tr>
<tr>
<td>Verbal memory for sounds reverse</td>
<td>.416**</td>
<td>.379**</td>
</tr>
<tr>
<td>Verbal memory for words</td>
<td>.11</td>
<td>.09</td>
</tr>
<tr>
<td>Verbal memory for sentences</td>
<td>.672**</td>
<td>.671**</td>
</tr>
<tr>
<td>Visual memory for Pictures</td>
<td>.431**</td>
<td>.397**</td>
</tr>
<tr>
<td>Visual memory for Letters</td>
<td>.339**</td>
<td>.309**</td>
</tr>
<tr>
<td>Reading marked words</td>
<td>.551**</td>
<td>.522**</td>
</tr>
<tr>
<td>Reading unmarked words</td>
<td>.690**</td>
<td>.664**</td>
</tr>
<tr>
<td>Reading accuracy text 1</td>
<td>.127</td>
<td>.088</td>
</tr>
<tr>
<td>Reading comprehension text 1</td>
<td>.427**</td>
<td>.416**</td>
</tr>
<tr>
<td>Reading rate text 1</td>
<td>.486**</td>
<td>.474**</td>
</tr>
<tr>
<td>Reading accuracy text 3</td>
<td>.285**</td>
<td>.251**</td>
</tr>
<tr>
<td>Reading rate text 3</td>
<td>.162</td>
<td>-.171*</td>
</tr>
<tr>
<td>Reading comprehension text 3</td>
<td>.587**</td>
<td>.556**</td>
</tr>
<tr>
<td>Reading accuracy text 5</td>
<td>.319**</td>
<td>.268**</td>
</tr>
<tr>
<td>Reading rate text 5</td>
<td>.476**</td>
<td>.452**</td>
</tr>
<tr>
<td>Reading comprehension text 5</td>
<td>.451**</td>
<td>.423*</td>
</tr>
<tr>
<td>Dictation word</td>
<td>.548**</td>
<td>.509**</td>
</tr>
<tr>
<td>Dictation text 2</td>
<td>.407**</td>
<td>.382**</td>
</tr>
</tbody>
</table>

**correlation is significant at the 0.01 level (2 tailed)
* correlation is significant at the 0.05 level (2 tailed)
To further explore the relationship between school experience and the development of reading and spelling skills, Pearson's correlation coefficients were calculated and presented in Table 6.4. Overall, reading and spelling measures were positively and significantly correlated with age and grade. The exceptions were the accuracy score on the easy first text and the rate of reading the unfamiliar third text. These relationships are mirrored in the phonological processing measures. For phoneme deletion, rapid naming and most short-term memory measures, significant correlations were found with age and grade; although more of these were smaller than those for the literacy measures, with the exception of those for the memory of sentence task. Where relationships with age and grade are not found, these are for measures with either ceiling effects (phoneme blending and segmentation) or for the more simple memory tasks involving highly familiar items (i.e., verbally presented letters and words that have to be recalled in order). These latter tasks seem to be well developed even by grade 1 amongst these children.

6.2.2.2. Predictors of literacy levels

Correlations between phonological awareness measures, rapid naming, short-term memory, isolated unmarked word reading (marked word reading was highly related to unmarked word reading and so the latter was included in these analyses given its larger variability) and word spelling were also calculated and presented in Table 6.5. With the exception of word reading and spelling, and word reading and sentence memory, these measures showed relatively small-to-medium inter-relationships suggesting that they are assessing somewhat different underlying skills within these children. As such, these measures were all included in the regression analyses performed to investigate the main predictors of literacy levels amongst these children.
Table 6.5. Pearson correlations between the potential literacy predictor measures in the study

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Phon del</th>
<th>Phon seg</th>
<th>Rapid nam</th>
<th>Read word</th>
<th>Dict words</th>
<th>Verb sound</th>
<th>Verb revs</th>
<th>Verb word</th>
<th>Verb sent</th>
<th>Vis pict</th>
<th>Vis let</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoneme Blending</td>
<td>.226**</td>
<td>.134</td>
<td>.107</td>
<td>-.037</td>
<td>.022</td>
<td>.064</td>
<td>.096</td>
<td>.107</td>
<td>.129</td>
<td>.073</td>
<td>.150</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td></td>
<td>.144</td>
<td>.228**</td>
<td>.376**</td>
<td>.261**</td>
<td>.038</td>
<td>.184</td>
<td>.216*</td>
<td>.403**</td>
<td>.247**</td>
<td>.297**</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td></td>
<td></td>
<td>.104</td>
<td>.140</td>
<td>.148</td>
<td>.193*</td>
<td>.009</td>
<td>.157</td>
<td>.096</td>
<td>.097</td>
<td>.160</td>
</tr>
<tr>
<td>Rapid Naming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.316**</td>
<td>.247**</td>
<td>.125</td>
<td>.242*</td>
<td>.214*</td>
<td>.250**</td>
</tr>
<tr>
<td>Reading Words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.521**</td>
<td>.300**</td>
</tr>
<tr>
<td>Dictation Words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.312**</td>
<td>.339**</td>
</tr>
<tr>
<td>Verb-memory Sounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.279**</td>
<td>.300**</td>
</tr>
<tr>
<td>Verb-memory Sounds reverse</td>
<td>0.011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.314**</td>
<td>.312**</td>
</tr>
<tr>
<td>Verb-memory Words</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.348**</td>
<td>.348**</td>
</tr>
<tr>
<td>Verb-memory Sentence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.302**</td>
<td>.212**</td>
</tr>
<tr>
<td>Vis-memory Pictures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.307**</td>
<td>.267**</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2 tailed)
* Correlation is significant at the 0.05 level (2 tailed)
In order to investigate potential predictors of literacy skills amongst these children, regression analyses were performed controlling for age and grade before using a stepwise procedure to determine the best predictors from the phonological processing measures. For the text measures, the single word literacy measures were also included in the regression analyses as were the scores on the other two measures on the text not assigned as the dependent variable.

For text reading, analyses were performed for each text separately (given the differing results described above) and investigated predictors of reading accuracy (Table 6.6), reading comprehension (Table 6.7) and reading rate (Table 6.8). These tables present the significant predictors identified after controlling for age and grade, with the $R^2$ values, followed by the $R^2$ values and the significance of this change, together with the beta value for the variable and its significance.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor</th>
<th>$R^2$</th>
<th>Adj $R^2$</th>
<th>$R^2$ change</th>
<th>F</th>
<th>p</th>
<th>Beta</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis-A-Text 1</td>
<td>Reading words</td>
<td>.08</td>
<td>.06</td>
<td>.05</td>
<td>3.92</td>
<td>.010</td>
<td>.326</td>
<td>.007</td>
</tr>
<tr>
<td>Analysis-B-Text 3</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis-C-Text 5</td>
<td>1-Reading words</td>
<td>.263</td>
<td>.239</td>
<td>.128</td>
<td>11.17</td>
<td>&lt;.001</td>
<td>.305</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>2-Memory for sounds</td>
<td>.335</td>
<td>.306</td>
<td>.072</td>
<td>11.69</td>
<td>&lt;.001</td>
<td>.277</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>3-Reading rate</td>
<td>.385</td>
<td>.352</td>
<td>.051</td>
<td>11.52</td>
<td>&lt;.001</td>
<td>.273</td>
<td>.007</td>
</tr>
</tbody>
</table>
Table 6.7. Regression analyses for text reading comprehension amongst the grade 1 to 5 children

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor</th>
<th>( R^2 )</th>
<th>Adj ( R^2 )</th>
<th>( R^2 ) change</th>
<th>( F )</th>
<th>( p )</th>
<th>Beta</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analysis-A-</strong></td>
<td><strong>Text 1</strong></td>
<td>.213</td>
<td>.194</td>
<td>.029</td>
<td>11.20</td>
<td>&lt;.001</td>
<td>.190</td>
<td>.035</td>
</tr>
<tr>
<td></td>
<td><strong>Visual memory for pictures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analysis-B-</strong></td>
<td><strong>Text 3</strong></td>
<td>.374</td>
<td>.359</td>
<td>.039</td>
<td>23.74</td>
<td>&lt;.001</td>
<td>.211</td>
<td>.003</td>
</tr>
<tr>
<td></td>
<td><strong>1-Reading rate</strong></td>
<td>.412</td>
<td>.392</td>
<td>.038</td>
<td>20.74</td>
<td>&lt;.001</td>
<td>.204</td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td><strong>2-Phoneme deletion</strong></td>
<td>.444</td>
<td>.420</td>
<td>.032</td>
<td>18.67</td>
<td>&lt;.001</td>
<td>.179</td>
<td>.011</td>
</tr>
<tr>
<td></td>
<td><strong>3-Memory for sounds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analysis-C-</strong></td>
<td><strong>Text 5</strong></td>
<td>.233</td>
<td>.209</td>
<td>.034</td>
<td>9.53</td>
<td>&lt;.001</td>
<td>.191</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td><strong>Visual memory for letters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6.8. Regression analyses for text reading rate amongst the grade 1 to 5 children

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor</th>
<th>( R^2 )</th>
<th>Adj ( R^2 )</th>
<th>( R^2 ) change</th>
<th>( F )-value</th>
<th>( p )-value</th>
<th>Beta</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analysis-A-</strong></td>
<td><strong>Text 1</strong></td>
<td>.481</td>
<td>.466</td>
<td>.154</td>
<td>32.75</td>
<td>&lt;.001</td>
<td>.491</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td><strong>1-Reading words</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>2-Rapid naming</strong></td>
<td>.512</td>
<td>.494</td>
<td>.031</td>
<td>27.58</td>
<td>&lt;.001</td>
<td>.192</td>
<td>.011</td>
</tr>
<tr>
<td><strong>Analysis-B-</strong></td>
<td><strong>Text 3</strong></td>
<td>.086</td>
<td>.063</td>
<td>.057</td>
<td>3.79</td>
<td>.012</td>
<td>.293</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td><strong>Reading comprehension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analysis-C-</strong></td>
<td><strong>Text 5</strong></td>
<td>.361</td>
<td>.336</td>
<td>.094</td>
<td>14.50</td>
<td>&lt;.001</td>
<td>.326</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td><strong>1-Reading accuracy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>2-Rapid naming</strong></td>
<td>.412</td>
<td>.381</td>
<td>.051</td>
<td>13.31</td>
<td>&lt;.001</td>
<td>.233</td>
<td>.012</td>
</tr>
</tbody>
</table>
Overall, these analyses predicted relatively small amounts of variability in the text reading measures once age and grade influences were controlled. This is perhaps unsurprising for text reading accuracy, given the ceiling effects in early grades. However, for text 5, reading unmarked isolated words did predict about 13% additional variability in accuracy scores over that of age and grade. This suggests that, at least by this grade level, those with weak text accuracy skills would also show evidence of problems reading unmarked words. Indeed, with the addition of verbal memory for sound and reading rate, these variables predicted about 35% to 38% of the variability in reading accuracy for text 5. The other obvious feature of these analyses is the variability in predictors. Although there is a tendency for word reading to predict text accuracy, short-term memory to predict reading comprehension and rapid naming to predict reading rate, the level of prediction is relatively low and the predictors are not consistent across all texts. Further work is therefore necessary to determine what predicts text reading levels in this population.

A final series of regression analyses focused on spelling. Here word and text spelling were used as dependent variables, as was the reading unmarked words task, given its potential to predict text reading accuracy. The results of these analyses can be found in Table 6.9.

As with the text reading analyses, these showed only limited amounts of variability explained by the measures. However, there was a tendency for memory for letters to be the main predictor of these dependent variables once age and grade influences were accounted for.
Table 6.9. Regression analyses for text spelling and word reading and spelling amongst the grade 1 to 5 children

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor</th>
<th>( R^2 )</th>
<th>Adj ( R^2 )</th>
<th>( R^2 ) change</th>
<th>F</th>
<th>p</th>
<th>Beta</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis-A-Reading words</td>
<td>Verbal memory for sounds</td>
<td>.493</td>
<td>.478</td>
<td>.022</td>
<td>34.29</td>
<td>&lt;.001</td>
<td>.149</td>
<td>.034</td>
</tr>
<tr>
<td>Analysis-B-Dictation Words</td>
<td>Visual memory for letters</td>
<td>.348</td>
<td>.330</td>
<td>.02</td>
<td>18.54</td>
<td>&lt;.001</td>
<td>.169</td>
<td>.047</td>
</tr>
<tr>
<td>Analysis-c-Dictation text</td>
<td>Visual memory for letters</td>
<td>.195</td>
<td>.172</td>
<td>.031</td>
<td>8.49</td>
<td>&lt;.001</td>
<td>.186</td>
<td>.048</td>
</tr>
</tbody>
</table>

6.3 Part B: Grades three to five

It is mentioned previously that the Persian language tests developed and described in chapter 5 were produced for the purposes of screening for dyslexia, particularly amongst grade 1 and 2 students. The data in Part A of this chapter indicated that ceiling effects are evident in a number of these measures, which may not be surprising given the aim of the tests. However, to assess further literacy and literacy-related skills in the Persian language amongst higher grades, this second part of the cross-sectional study included more complex measures of these skills and targeted children in grades 3 to 5 of normal schools in Tehran. As in the previous part, literacy was assessed using isolated words and connected text, and phonological processing was measured with tasks requiring an awareness of sounds within words, the ability to retain verbal material in short-term memory and the rapid access of verbal labels.
6.3.1 Method

6.3.1.1 Participants
The sample group consisted of 64 primary school children in grades 3, 4 and 5 (21, 20 and 23 respectively) of whom 32 were boys and 32 were girls (ranging in age between 8 and 12 years old). This sample was selected, based on the same criteria as in Part A, from four public primary schools, in the northern and eastern regions of Tehran (Iran).

6.3.1.2 Material and procedure:
Phonological processing was assessed by more complex blending and segmentation tasks, which, compared to the measures used in Part A, comprised longer, less familiar words for the children assessed. Again, percentage correct scores were used in analyses for comparison purposes. In addition to these awareness tasks, and instead of the phoneme deletion, which did show grade effects in Part A, a Persian Spoonerism task was developed. In this task, the child was verbally presented with two Persian words and was required to repeat the words with the initial sound of each word exchanged (as in the English language version where word pairs such as King John need to be transposed to Jing Kon by the child). Five trials were used in the task, following instruction and practice, with items increasing in length of utterance over the trials. The number of correct pronunciations produced was used as the measure for this task, with percentage correct figures being reported in the results. This task, therefore, places a load on working memory, as well as assessing the individual's awareness of sounds within words.

Phonological memory was assessed using the verbal memory for words task used in Part A as this task most closely corresponds to the typical short-term memory tasks used in dyslexia
assessments (see discussions in Everatt, McNamara, et al, 1999). Although this task did not show grade effects in Part A, the present task was made harder by varying the items used so that they would be less familiar to the child. Apart from this variation, the task was the same as in Part A, and the same variation in items was used for the assessment of phonological access. In Part B, instead of naming drawings of common objects, the child required to name a sequence of 50 individual digits as quickly as possible. This task was based on that used in the Phonological Assessment Battery (Frederickson, Frith & Reason, 1996). Digits were presented in five rows of ten items, with the child being required to start from the top left-hand item and name from left to right (in contrast to the naming pictures task in which items were named from right to left) based on the direction of reading numbers used in Persian. The time taken to name all 50 items was recorded and converted to naming rate as in Part A.

Reading out of context was assessed by word and non-word reading measures. In these tasks, participants were presented with a list of 30 meaningful, low and high frequency words, and with 10 nonsense pseudo-words, and were asked to read these letter strings aloud as accurately as possible. Regular and irregular unmarked words were used to increase complexity. These words were chosen from grades 3-5 textbooks. The non-words were derived from existing Persian words, but with letters manipulated to produce a non-meaningful letter string that was pronounceable using Persian letter-sound conversion strategies. As such, this task was used to assess decoding skills amongst the grade 3 to 5 children. For word and non-word lists, accuracy of reading based on the number of items correct and the time taken to complete the lists were recorded. Accuracy scores were converted to percentage correct and times were converted to rate, as in Part A.
Text reading accuracy, speed and comprehension were again used to assess the children's ability to process connected text. In contrast to Part A, the task was made more complex by using non-familiar extracts of text chosen from higher grade textbooks. Reading speed was obtained in the same way as the previous part of the study and converted to the number of words read per minute. Reading accuracy was based on the percentage of words read correctly and reading comprehension was calculated as the percentage of comprehension questions answered correctly.

Spelling was assessed by giving the child sixty single words to write down to dictation. Grade 3, 4 and 5 textbooks were used to obtain the words, with twenty words being selected from each grade level. The complexity of the words increased from one syllable words (at the start of the test) to five syllable words (towards the end of the test). To spell these words correctly, the candidate needed a visual/orthographic concept of the words as well as decoding skills, due to the fact that more than 90 percent of the words included phonemes that could be represented by several letters. The number of words spelt correctly was recorded and converted to a percentage correct score.

6.3.2 Results

6.3.2.1 Descriptive statistics and comparisons across grades

The performance of pupils from grades 3 to 5 is illustrated in Tables 6.10. A one-way analysis of variance was performed on each of these measures to investigate any significant effects of a grade on these scores. Following a significant anova, Tukey post-hoc pairwise comparisons were then performed to identify which grade differed significantly from another.

Overall, the Spoonerism task, which place heavy demands on phonological working memory, appeared to be the most difficult phonological awareness task in this part of study. Although
there was a non-significant difference between grades, the mean scores indicated some level of improvement over the grades assessed. Given that by grade 5, still only 50% of the items were pronounced correctly, these data suggest that such more complex phonological tasks will continue to improve up to later schooling. Similar results were found in Part A of this study when phoneme deletion was measured. Similarly, the blending and segmentation tasks, which were made comparatively harder in this part of the study, showed evidence of improvements over the grades assessed, with grade 3 typically performing at a lower level to the older grades. Despite this, by grade 4, the children were reaching good levels of performance, particularly in phoneme segmentation (see Figures 6.9 and 6.10). Hence, phonological awareness skills seem to be well developed amongst such Persian speaking children in the early years of literacy acquisition, although these skills can be seen to be improving up to grade 5 and possibly beyond.

Figures 6.9 and 6.10 suggest some variability in performance between male and female participants. Therefore, two-way analyses of variance were performed to assess any potential interaction between grade and sex. These indicated non-significant interactions for all measures (F<1 in the majority of cases and p>.15 in the rest) except the rapid naming measure (F=4.46, p=.02), with simple main effects of grade suggesting a significant effect amongst girls (p<.05) but not amongst boys (p>.10). An individual effect such as this will require further research to confirm prior to explanations being attempted. In addition to this sole interaction effect, the only main effects of sex in these analyses were for the Spoonerisms task (F=4.28, p=.04) and the Phoneme blending task (F=8.86, p=.004). Overall, therefore, these findings suggest a general trend for improvements across grades across male and female participants, but for some evidence of better performance amongst girls than boys.
Table 6.10. Means, standard deviations (in parentheses) and the results of ANOVA and post-hoc tests on the scores of the grade 3 to 5 pupils

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>F</th>
<th>p</th>
<th>Post hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Naming rate</td>
<td>117.58 (25.87)</td>
<td>128.17 (20.65)</td>
<td>133.18 (29.81)</td>
<td>2.04</td>
<td>.138</td>
<td>Not sig</td>
</tr>
<tr>
<td>Spoonerisms</td>
<td>37.61 (32.84)</td>
<td>47.00 (28.48)</td>
<td>55.21 (30.13)</td>
<td>1.82</td>
<td>.171</td>
<td>Not sig</td>
</tr>
<tr>
<td>Phoneme Blending</td>
<td>38.00 (21.42)</td>
<td>63.00 (20.02)</td>
<td>62.17 (27.29)</td>
<td>5.86</td>
<td>.005</td>
<td>3&lt;4,5</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>74.82 (16.60)</td>
<td>85.99 (11.72)</td>
<td>82.97 (13.04)</td>
<td>3.56</td>
<td>.034</td>
<td>3&lt;4</td>
</tr>
<tr>
<td>Verb-memory: words</td>
<td>4.29 (0.56)</td>
<td>4.60 (0.59)</td>
<td>4.61 (0.58)</td>
<td>2.13</td>
<td>.128</td>
<td>Not sig</td>
</tr>
<tr>
<td>Reading non words</td>
<td>90.00 (10.25)</td>
<td>93.50 (9.88)</td>
<td>93.04 (10.07)</td>
<td>.71</td>
<td>.492</td>
<td>Not sig</td>
</tr>
<tr>
<td>Non-word reading rate</td>
<td>27.64 (15.93)</td>
<td>28.36 (11.78)</td>
<td>27.04 (6.88)</td>
<td>.066</td>
<td>.93</td>
<td>Not sig</td>
</tr>
<tr>
<td>Reading words</td>
<td>49.99 (19.03)</td>
<td>54.49 (12.05)</td>
<td>74.40 (14.90)</td>
<td>15.31</td>
<td>&lt;.0005</td>
<td>3,4&lt;5</td>
</tr>
<tr>
<td>Word reading rate</td>
<td>23.32 (9.90)</td>
<td>29.42 (8.06)</td>
<td>53.46 (32.27)</td>
<td>13.13</td>
<td>&lt;.0005</td>
<td>3,4&lt;5</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>95.28 (4.97)</td>
<td>96.61 (2.39)</td>
<td>97.39 (2.31)</td>
<td>2.08</td>
<td>.133</td>
<td>Not sig</td>
</tr>
<tr>
<td>Reading rate</td>
<td>79.33 (25.50)</td>
<td>91.83 (27.08)</td>
<td>103.07 (31.39)</td>
<td>3.77</td>
<td>.029</td>
<td>3&lt;5</td>
</tr>
<tr>
<td>Reading comprehension</td>
<td>40 (27.38)</td>
<td>55.40 (25.98)</td>
<td>63.04 (24.85)</td>
<td>4.28</td>
<td>.018</td>
<td>3&lt;5</td>
</tr>
<tr>
<td>Spelling words</td>
<td>56.19 (21.32)</td>
<td>60 (21.27)</td>
<td>82.17 (20.43)</td>
<td>9.89</td>
<td>&lt;.0005</td>
<td>3,4&lt;5</td>
</tr>
</tbody>
</table>
Figures 6.9 and 6.10. Graphical presentation of the level of performance of male and female students across grades 3-5

The children presented with a high level of accuracy in the non-word reading task, particularly in comparison to their scores on the word reading measure. This accuracy level may be a result of high level of decoding skills which younger students usually obtain during first grade, potentially due to the phonic method of teaching reading and spelling used in early learning, and the large amount of practice in reading transparent (i.e., fully marked)
Persian texts during these years. When unmarked words were used in reading, accuracy levels fell, and even by grade 5 only 75% of words were recognised and pronounced accurately. These findings suggest the importance of skills other than phonic decoding for the reading of isolated words in Persian. However, when words were presented in context, accuracy levels were found to be high, even amongst third graders, the youngest Persian readers in this part of the study. When text reading was assessed, it was reading rate and comprehension (see Figure 6.11) that showed improvements of grades. The reading rate effect was matched in the single word reading task, which also showed improved rates of word identification.

**Figure 6.11.** Graphical presentation of the level of performance of male and female students across grades 3-5 on the reading comprehension measure

![Graphical presentation](image)

To further explore the relationship between school experience and the development of reading and spelling skills, Pearson’s correlation coefficients were calculated and presented
in Table 6.11. Overall, the reading measures were positively and significantly correlated with age and grade, in contrast to the relationships found with word spelling. These relationships with reading were similar to those found for the phonological processing measures, although the correlations were smaller and less likely to be significant for this cohort of children when phonological skills were considered compared to reading scores.

Table 6.11. Pearson's Correlations between the measures and age and grade of the grade 3 to 5 children

<table>
<thead>
<tr>
<th>Variables</th>
<th>age</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid naming of digits</td>
<td>.216</td>
<td>.246</td>
</tr>
<tr>
<td>Spoonerisms</td>
<td>.155</td>
<td>.237</td>
</tr>
<tr>
<td>Phoneme blending</td>
<td>.338*</td>
<td>.344**</td>
</tr>
<tr>
<td>Phoneme segmentation</td>
<td>.195</td>
<td>.229</td>
</tr>
<tr>
<td>Verbal memory for words</td>
<td>.221</td>
<td>.225</td>
</tr>
<tr>
<td>Word reading</td>
<td>.473**</td>
<td>.546**</td>
</tr>
<tr>
<td>Word Reading Rate</td>
<td>.534**</td>
<td>.521**</td>
</tr>
<tr>
<td>Non-word reading</td>
<td>.065</td>
<td>.122</td>
</tr>
<tr>
<td>Non-word reading rate</td>
<td>-.105</td>
<td>.023</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>.339**</td>
<td>.461**</td>
</tr>
<tr>
<td>Reading comprehension</td>
<td>.290*</td>
<td>.347**</td>
</tr>
<tr>
<td>Reading Rate</td>
<td>.252*</td>
<td>.334**</td>
</tr>
<tr>
<td>Word spelling</td>
<td>.148</td>
<td>.099</td>
</tr>
</tbody>
</table>

**correlation is significant at the 0.01 level (2 tailed)
6.3.2.2. Predictors of literacy levels

In order to investigate potential predictors of literacy skills amongst these children, regression analyses were performed controlling for age and grade before using a stepwise procedure to determine the best predictors from the phonological processing measures and literacy measures. Table 6.12 presents the significant predictors identified after controlling for age and grade, with the $R^2$ values, followed by the $R^2$ values and the significance of this change, together with the beta value for the variable and its significance.

Table 6.12. Regression analyses for the grade 3 to 5 children

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictor</th>
<th>$R^2$</th>
<th>Adj $R^2$</th>
<th>$R^2$ change</th>
<th>$F$</th>
<th>$p$</th>
<th>Beta</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis-A-</td>
<td>1-Spoonerisms</td>
<td>.486</td>
<td>.460</td>
<td>.218</td>
<td>18.62</td>
<td>&lt;.001</td>
<td>.278</td>
<td>.009</td>
</tr>
<tr>
<td>Reading accuracy</td>
<td>2-Reading rate</td>
<td>.565</td>
<td>.535</td>
<td>.079</td>
<td>18.86</td>
<td>&lt;.001</td>
<td>.301</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>3-Segmentation</td>
<td>.598</td>
<td>.563</td>
<td>.033</td>
<td>16.98</td>
<td>&lt;.001</td>
<td>.204</td>
<td>.035</td>
</tr>
<tr>
<td>Analysis-B-</td>
<td>1-Reading rate</td>
<td>.280</td>
<td>.243</td>
<td>.152</td>
<td>7.63</td>
<td>&lt;.001</td>
<td>.456</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Reading comprehension</td>
<td>2-Segmentation</td>
<td>.391</td>
<td>.349</td>
<td>.112</td>
<td>9.32</td>
<td>&lt;.001</td>
<td>.344</td>
<td>.002</td>
</tr>
<tr>
<td>Analysis-C-</td>
<td>1-Word reading</td>
<td>.434</td>
<td>.405</td>
<td>.298</td>
<td>15.05</td>
<td>&lt;.001</td>
<td>.629</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Reading rate</td>
<td>2-Blending</td>
<td>.587</td>
<td>.558</td>
<td>.153</td>
<td>20.59</td>
<td>&lt;.001</td>
<td>.420</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Analysis-D-</td>
<td>1-Spoonerism</td>
<td>.459</td>
<td>.432</td>
<td>.09</td>
<td>16.70</td>
<td>&lt;.001</td>
<td>.263</td>
<td>.011</td>
</tr>
<tr>
<td>Word reading</td>
<td>2-Naming speed</td>
<td>.511</td>
<td>.477</td>
<td>.05</td>
<td>15.15</td>
<td>&lt;.001</td>
<td>.243</td>
<td>.016</td>
</tr>
<tr>
<td>Analysis-E-</td>
<td>Reading</td>
<td>.419</td>
<td>.390</td>
<td>.123</td>
<td>14.21</td>
<td>&lt;.001</td>
<td>.375</td>
<td>.001</td>
</tr>
<tr>
<td>Word rate</td>
<td>comprehension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis-F-</td>
<td>Spoonerisms</td>
<td>.483</td>
<td>.457</td>
<td>.241</td>
<td>18.36</td>
<td>&lt;.001</td>
<td>.512</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Word spelling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Although none of the phonological measures were found to be good predictors of reading accuracy in Part A of this work, the present data suggest that the Spoonerisms task is a reasonable predictor of variability in literacy accuracy in this older cohort, with both isolated and context based reading and word spelling being predicted by scores on this task. Reading rate and comprehension, however, were more likely to be predicted by other measures of reading levels, although segmentation and blending scores did provide some level of prediction in the text reading measures in addition to the rate and accuracy measures. Overall, these findings were consistent with phonological skills developing along-side literacy within the Persian learning reader and speller.

6.4 Discussion

There has been much research into trying to understand the underlying mechanisms in learning to read and write, and into the failure to acquire literacy skills. Much of this research has been carried out in the English language, though there are a number of articles written concerning other languages. Reading and writing in transparent scripts, such as German, Spanish and Greek, have been widely researched in the past decade. These languages offer similarities in their demands on phonological processing which may be considered, at least in part, as a function of their degree of phoneme-grapheme correspondence (or transparency). Farsi (Persian) is often cited as being an easy language to learn due to its transparency and regularity. The finding of this study were consistent with the view that phonological skills are important for the development of literacy in Persian, although the level of prediction provided was less than might be predicted based on current English-language-based models of literacy acquisition.
The normal path of reading acquisition in Persian seems to commence with an initial phonological word-decoding stage. This could be related to the nature of the orthography, as well as phonic method of teaching. The data from the current study suggest that although Persian language children may have access to both phonological and lexical reading strategies and seem to adapt word recognition according to the demands of each specific reading task, they seem to rely on decoding skills to read non-words and unfamiliar text, potentially up to and beyond grade 5. The beginner Persian reader is similar to the Arabic beginner (AlMannai & Everatt, 2005) in that they experience mainly text containing vowel markers (diacritics) that specify symbol-sound relationships and make the script highly transparent. These markers are often missing from more advanced texts that pupils beyond the initial grades are likely to encounter. As such, the Persian reader seems to improve in accuracy relatively quickly compared to what might be expected of the English literacy learner. The studies reported in subsequent sections of this thesis were designed to contrast Persian and English early literacy learners to provide data to assess hypothesized differences more formally.

However, it is possible that the initial advantage for early Persian literacy learning may not necessarily lead to advantages when more advanced literacy skills are considered. That is, phonological decoding strategies may develop well and lead to good levels of improvement in measures of word reading accuracy. However, to pass from a phonological decoding stage to more automatic word reading skills may require practice with different kinds of potentially unfamiliar texts that the Persian learning child may not experience. The effects of this lack of experience, and hence automaticity, seem more likely to be found in rate of reading measures rather than accuracy. For example, in the first study in this chapter, which contrasted grades 1 to 5, text 3 was an unfamiliar text for these children. Despite the level of word knowledge
being consistent with that likely of a grade 1 child, the results reported on page 92 suggest that grade 4 and 5 children were slow readers of this text — slower even than their younger counterparts. This seems to correspond to differences in accuracy and comprehension. The grade 4 and 5 children seemed to be slowing reading down to reach near perfect levels of accuracy and comprehension, in contrast to the younger children where rate was better, but accuracy and comprehension were less than optimal. The grade 4 and 5 children may be good decoders, but slower rates seem to suggest that they may not be entirely fluent word readers; i.e., automatic processing of words has not yet developed completely. If this interpretation is correct, the results of the work presented in this chapter argue for Farsi speaking children to use their phonological decoding skills to read unfamiliar and/or low frequency words. This may be related to the regularity of the orthography at this stage of learning, but also to the phonological training they have been having since their first grade in formal education. Such good phonological decoding skills would be consistent with the high scores produced in the measures of phonological segmentation and blending. Although this results in good accuracy levels, it may be at the expense of slower rates of reading. Such a process may be of particular disadvantage for those children who do not get enough exposure to reading materials other than those used in their school text books. These children may be restricted in their reading practice and, hence, would be less likely to become automatic word readers. This may lead to slower reading and less understanding, which may impact on their progress in higher grades and in other subjects where text comprehension rather than word accuracy is vital. Very recently, in some private schools in Iran, teachers have started using whole-word recognition methods of teaching to complement phonics-based methods. The view here is that the latter methods will ensure that phonological decoding strategies are learnt, but the whole-word methods should encourage automatic word identification processes to develop. Clearly, future research in this area, contrasting different Farsi teaching methods, would be
useful to inform views about how reading and writing skills develop in this language.

Overall, the data reported in this chapter should provide useful information for future work. However, the limitations of this research need to be considered. For example, some of the regression analyses in the second study reported in this chapter were performed on relatively small numbers of children. This may mean that unusual scores may have effects on the findings that a larger sample would overcome – i.e., a large sample would reduce error variance. Although the conclusions across the studies were reasonably consistent, this caution needs to be taken into account and the findings further replicated to allow more firm conclusions to be presented.

In addition, the focus of the present work was on measures of phonological processing, which may lead to limitations in the areas assessed by the measures used. Currently, there are no measures of more complex visual processing in Farsi. The present methods did include measures of visual memory; however, these would be influenced by language (i.e., naming items, such as in tasks of short-term object memory or requiring the rapid naming of object). Although visual tasks were included in pilot work preceding the data reported in this thesis, these measures produced ceiling effects that meant that interpretation of the results was not possible. Given the focus of the present work, more complex versions, therefore, were not developed. However, clearly, this is an area of potential individual differences in reading acquisition that would benefit from further research to assess its impact on Farsi learning. Indeed, the intricacies of the orthography may be particularly pertinent here (see Chapter 4), with letter shapes varying dependent on their position in a word and dots or lines above or below a constant shape being used to distinguish between different letters. The addition of such measures in a study of predictors of literacy may increase the level of prediction.
provided in regression models. In addition, the amount of variability explained by such regression models also may be increased by varying the complexity of the measures used in the study. The present work focused on informing the development of measures to support the identification of children with dyslexia. Therefore, measures that can be used with older and more able/experienced children were not the target of this work. Further research in this area, though, may want to consider increasing the complexity of measures to increase their sensitivity for older and higher performing groups of Farsi speaking children.

Finally, there was some evidence in the results for differences between boys and girls on some of the measures. These differences may require further assessment to determine their potential influence on the measures used, particularly if the tests were to be normed for use in educational practice – it may be that different norms will be needed for boys and girls. However, because the present work did not aim to contrast males and females on the tests, and due to the requirements of time and resources, sex differences were only of minor consideration in the analyses. Larger samples, potentially controlling for additional factors outside the control of this study (e.g., background of boys versus girls), will be needed before sex differences can be more formally assessed and inform norming procedures.
Chapter 7
A cross-language study of Persian versus English children

7.1 Introduction
This study investigated commonalities between Persian and English in terms of phonological-based predictors of literacy skills. Commonalities would be consistent with the same underlying factors leading to different levels of literacy ability in these two languages. These data should inform the view about whether models of literacy ability and disability (dyslexia) derived from English language subjects are applicable to Persian speaking children.

7.2 Method
7.2.1 Participants
Two cohorts of children were selected for this study. Both cohorts comprised grade/year 3 and 4 children from government funded schools in the capital cities (Tehran and London) of the two countries where testing was performed. The Persian speaking children comprised 20 grade 3 and 20 grade 4 children. All schools in Tehran, regardless of geographical location, use the same curriculum, with all textbooks being exactly the same across schools, so the sample taken should be representative of children across the sector. Children were selected based on information from school records indicating that they presented no evidence of literacy learning problems and consent of parents and teachers. The native language of all the children tested was Persian, and they had no knowledge of any other language. Details of age and sex ratio for the sample can be found in Table 7.1.

The 50 children who comprised the English speaking cohort were also roughly equally divided between year 3 and year 4, as well as in terms of sex ratio (see Table 7.1). However,
due to children starting school one year earlier in England compared to Iran, the English speaking children were slightly younger than their Iranian counterparts (see Table 7.1). The English cohort was selected from a school that followed a typical curriculum and which presented no evidence of problems in terms of sector league tables and inspection results. Hence, the school was considered typical for the sector. Children across the year groups were selected based on no documented learning problems and guardian consent. All of the children were first language native English speakers and as far as interviews could determine spoke no other language.

Table 7.1. Background details for the Persian and English speaking children in the study

<table>
<thead>
<tr>
<th></th>
<th>Persian</th>
<th></th>
<th>English</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade 3</td>
<td>Grade 4</td>
<td>Year 3</td>
<td>Year 4</td>
</tr>
<tr>
<td>Number of children</td>
<td>20</td>
<td>20</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Average age in months</td>
<td>110.95 (4.21)</td>
<td>122.05 (2.93)</td>
<td>99.27 (2.65)</td>
<td>106.38 (2.16)</td>
</tr>
</tbody>
</table>
7.2.2 Tasks and procedures

The two cohorts of children experienced different literacy and phonological processing measures devised for the local context in which testing was performed. However, both batteries of tests covered the same range of literacy skills (word reading and spelling and text reading) as well as phonological skills (phonological awareness and manipulation, phonological memory and access). For the both cohorts, tests measured single word reading accuracy, text reading comprehension, word spelling, non-word reading, Spoonerisms and phonological awareness, word span and rapid naming.

All children were examined individually in a quiet room, away from distractions and other children. The full testing procedure took approximately one hour and was performed over several days to avoid fatigue. Test administrators were trained researchers/therapists who were familiar with the test materials and procedures. All were native speakers of the language in which testing was performed. Within each language cohort, the tester followed a prescribed/common testing procedure.

Persian Word Reading

Thirty meaningful words were chosen from grades 3 to 5 textbooks used as part of the normal schooling of the children. Regular and irregular words were selected that varied in frequency of occurrence in the text books, leading to variability in complexity of reading for the grade 3 and 4 children tested. All words included only those diacritic markers that allowed word reading in isolation. The children were asked to read each word aloud. The number of words correctly pronounced was used as the measure for this task.
Persian Text Comprehension

Two unfamiliar passages were taken from appropriate grade-level text books. The first was relatively easy in terms of familiarity of material, whereas the second was relatively more complicated in its usage of terms and its scientific nature. The first passage comprised 145 words and 4 comprehension questions were derived from this passage. The second passage comprised 112 words and 6 comprehension questions were used with this passage. Children were asked to read the passage presented (the easier passage was always given first) aloud to the tester. When the passage had been read, the tester asked the child the associated comprehension questions, each of which required the child to have understood a section of the passage and to respond with a single word or simple phrase. The number of correct answers was recorded by the tester, with the child’s text comprehension score being based on the number of comprehension questions out of 10 correctly answered across the two passages.

Persian Word Spelling

For this test, the two grades were presented with 20 different words to spell that were taken from grade appropriate texts; ie, the grade 3 children were given grade 3 words and the grade 4 children were given grade 4 words. Words were presented in isolation and increased from one syllable words at the start of the test to five syllable words at the end. After each word was spoken to the children, they were asked to write the word on the paper provided for them. A gap between words was used to allow the children time to write down each item. After all the words were presented, the sheet of paper was collected and the number of words correctly spelt was used as the measure for this task.
**Persian Non-word Reading**

The child was presented with 10 letter strings that were not in the Persian vocabulary, but which were pronounceable based on the application of correct letter-sound conversion rules. Non-words were derived by changing the sequence of letters within real words or by substituting letters within real words. These manipulations ensure that the sequence of letters was still possibly in the language/script, and that they formed a pronounceable pseudoword. The child was asked to read aloud each item to the tester, with the number of correct pronunciations being used as the measure in this test.

**Persian Phonological Manipulation**

A Spoonerisms task was selected to assess more complex phonological skills. This was based on a typical Spoonerisms procedure (such as that in the Phonological Assessment Battery, Frederickson et al, 1996) in which two words are spoken by the tester and the child has to repeat the words but with the first sound from each word exchanged between the words (ie, King John becomes Jing Kon). The child was presented with 5 of these two word sequences. Based on the verbal response of the child, two marks were given if both items in a trial were correct, one mark was given if only one of the two was correct, and no marks were given if neither of the items was correctly spoken.

**Persian Phonological Awareness**

This task consisted of 5 real target words which were verbally presented to the child as a sequence of phonemes that the child had to blend to produce the target word. Each phoneme was presented individually and separated from the other phonemes by a pause. The child was asked to state the word that the sounds made. For example, the tester would say ‘what word does this produce? /b/, /u/’, and a pause would indicate that a response was required (in this
case the word is bu means smell in English). The number of phonemes required to produce the target word was increased over the course of the task from two to five. The number of target words correctly produce was used as the measure for this task.

**Persian Rapid Naming**

This task was derived from that used in the Phonological Assessment Battery (Frederickson et al, 1996). Five rows of 10 randomly orders digits were presented to the child. The child was asked to name each of the items on the page starting at the top of the page and working from left to right consistent with the direction of reading digits. They were told to name each digit as quickly but as accurately as possible. Familiarity with digit names was ensured prior to the test. Uncorrected errors were rare in the data, so scores for the task were based on the times taken in seconds to name all 50 digits. A score for the task was derived by taking the number of items named, dividing by the time taken and multiplying by 60 to give the number of digits names per minute.

**Persian Verbal Memory**

This task was based on digit span procedures used in many test procedures. In the present study, however, words were used instead of digits to control pronunciation length by selection only three-phoneme, one-syllable words that were relatively frequent in occurrence in the children’s speech and reading materials. Trials range from between two words up to seven, with one trial being available per series length. The tester verbally presented the words, followed by a pause indicating that the child was to verbally repeat the items presented in the correct order. The number of words in the trial prior to failure at a particular series length was used as a measure of memory span in this task.
**English Word Reading**

The single word reading was based on the Schonell Single Word Graded Reading Test (Schonell and Schonell, 1956). A list of 60 individual words, graded in order of difficulty and without contextual cues was presented to the child who was asked to read each word aloud to the tester. Each child was given a score based on the number of words read correctly.

**English Text Comprehension**

The text reading measure was based on the Primary Reading Test (France, 1981) and required the child to read silently individual sentences. Each of these sentences was incomplete, and the child was asked to select from a list of 5 words that accompanied each sentence the one that completed the sentence most appropriately. The score for this task was the number of sentences completed correctly out of 40.

**English Word Spelling**

The spelling test was based on the procedures of the Vernon Graded Word Spelling Test (Vernon, 1997). Each word from a list of 30 was individually and orally presented, followed by presentation of the word in the context of a sentence and lastly individually presented again. The child was instructed to write down the single words and not the sentences. The number of correctly spelt words was used as the score for this measure.

**English Non-word Reading**

This measure was taken from the Phonological Assessment Battery (Frederickson et al, 1996). The child’s task was to read aloud to the tester 20 letter strings that were pronounceable based on English letter-sound conversion rules, but which did not have a meaning in the English language. The first 10 non-words were one syllable, the remainder
were two syllables in pronunciation length. The number of correct readings (based on manual descriptions) was used as the measure in this task.

**English Phonological Manipulation**

This Spoonerisms task was also taken from the Phonological Assessment Battery (Frederickson et al, 1996). Initially, the child is required to replace the first sound of a given word with another sound (eg, cot with a /g/ sound gives ‘got’). There are 10 items in this stage of testing. The remaining 20 items require the child to replace initial sounds across two verbally presented words (‘sad cat’ gives ‘cad sat’). The number of correct answers out of a total of 30 items is used as the score in this test based on manual procedures.

**English Phonological Awareness**

This task was based on the phonological awareness task used in the Dyslexia Screening Test (Fawcett & Nicolson, 1996) and was used to assess the child’s ability to perform relatively (compared to the Spoonerisms task) simple phonological awareness tasks. The child is required to say a word without part of the word (eg, say ‘rainbow’ without the /bow/ sound; or say ‘boat’ without the /b/ sound; or say ‘igloo’ without the /l/ sound). In total, 13 items were used, which increased in complexity based on the type of segmentation required. The child’s score was the number of items correct out of 13.

**English Verbal Memory**

A typical digit span procedure (eg, as in the Bangor Dyslexia Test; Miles, 1993) was used for this measure, except that one syllable names of concrete objects were used as items in the task instead of digits. This change of items was for consistency with the Persian version of this task. Sequence lengths were increased from two word sequences to eight word
sequences, and the length of the last sequence on which a correct response was produce was used as the measure in this task.

*English Rapid Naming*

Consistent with the Persian version of this task, a sequence of digits was presented to the child who was required to name each digit in the sequence as quickly but as accurately as possible. There were 40 digits in the sequence, which was randomly produced and this sequence was repeated once, with the total times taken to name both sequences recorded. The number of uncorrected errors was relatively few, so the times were not corrected.

### 7.3 Results

Tables 7.2 and 7.3 show the results for the Persian and English speaking children respectively. Inspection of these summary statistics indicates a reasonable range in scores across most of the tasks. The main exception to this was the Persian Non-word Reading measure which shows a ceiling effect in performance consistent with the regular nature of the orthography used in this task. The same high level of performance was not found in the English version of this task, suggesting that regularity of spelling-sound rules leads to variations in letter string decoding skills (see section 3.4, for similar findings in the literature).

Table 7.4 shows the inter correlations between the measures for each language cohort. Consistent with the view that the measures of phonological processing may be measuring different constructs, the inter correlations between non word reading, phonological awareness and manipulation, verbal memory and rapid naming show some level of independence, particularly in the Persian data. For both data sets, the inter correlations within literacy
measures are larger than those found for the phonological measures. However, there are reliable correlations between measures of literacy and phonological processing, indicating a level of prediction from one skill to the other.

**Table 7.2.** Means and standard deviations in brackets for the Persian speaking grade 3 and 4 children, and the whole cohort with ranges in square brackets, on each of the literacy and phonology measures

<table>
<thead>
<tr>
<th></th>
<th>grade 3 (N=20)</th>
<th>grade 4 (N=20)</th>
<th>total (N=40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word reading</td>
<td>14.40 (5.13)</td>
<td>16.35 (3.62)</td>
<td>15.37 (4.49)</td>
</tr>
<tr>
<td>Text comprehension</td>
<td>2.65 (1.84)</td>
<td>3.90 (1.74)</td>
<td>3.28 (1.88)</td>
</tr>
<tr>
<td>Spelling</td>
<td>13.50 (3.25)</td>
<td>12.40 (2.72)</td>
<td>12.95 (3.01)</td>
</tr>
<tr>
<td>Nonword reading</td>
<td>8.80 (1.20)</td>
<td>9.35 (0.99)</td>
<td>9.08 (1.12)</td>
</tr>
<tr>
<td>Spoonerisms</td>
<td>3.95 (3.25)</td>
<td>4.70 (2.85)</td>
<td>4.33 (3.04)</td>
</tr>
<tr>
<td>Phono awareness</td>
<td>1.90 (1.07)</td>
<td>3.15 (1.50)</td>
<td>2.53 (1.43)</td>
</tr>
<tr>
<td>Rapid naming</td>
<td>117.46 (26.54)</td>
<td>128.17 (20.65)</td>
<td>122.82 (24.09)</td>
</tr>
<tr>
<td>Memory span</td>
<td>4.30 (0.57)</td>
<td>4.60 (0.60)</td>
<td>4.45 (0.60)</td>
</tr>
</tbody>
</table>
Table 7.3. Means and standard deviations in brackets for the English speaking grade 3 and 4 children, and the whole cohort with ranges in square brackets, on each of the literacy and phonology measures.

<table>
<thead>
<tr>
<th></th>
<th>grade 3 (N=26)</th>
<th>grade 4 (N=24)</th>
<th>total (N=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word reading</td>
<td>20.81 (11.16)</td>
<td>22.67 (12.83)</td>
<td>21.70 (11.90)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[0-52]</td>
</tr>
<tr>
<td>Text comprehension</td>
<td>16.35 (6.08)</td>
<td>18.38 (7.01)</td>
<td>17.32 (6.55)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[9-34]</td>
</tr>
<tr>
<td>Spelling</td>
<td>11.15 (4.16)</td>
<td>12.42 (5.17)</td>
<td>11.76 (4.67)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[0-25]</td>
</tr>
<tr>
<td>Nonword reading</td>
<td>11.50 (2.34)</td>
<td>12.38 (4.00)</td>
<td>11.92 (3.24)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[6-20]</td>
</tr>
<tr>
<td>Spoonerisms</td>
<td>18.85 (5.57)</td>
<td>19.63 (4.94)</td>
<td>19.22 (5.24)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[3-30]</td>
</tr>
<tr>
<td>Phono awareness</td>
<td>11.89 (1.53)</td>
<td>11.68 (2.46)</td>
<td>11.78 (2.01)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2-13]</td>
</tr>
<tr>
<td>Rapid naming</td>
<td>42.89 (21.35)</td>
<td>41.07 (21.40)</td>
<td>42.02 (21.18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[24-129]</td>
</tr>
<tr>
<td>Memory span</td>
<td>4.62 (0.80)</td>
<td>4.58 (0.97)</td>
<td>4.60 (0.88)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2-7]</td>
</tr>
</tbody>
</table>
Table 7.4. Correlations between literacy and phonological processing measures for the Persian (top, right hand section) and English (bottom, left hand section) speaking children.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Word reading</th>
<th>Spell</th>
<th>Comp</th>
<th>Non-word</th>
<th>Phon awareness</th>
<th>Spooner</th>
<th>Word span</th>
<th>Naming speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word reading</td>
<td></td>
<td>.380*</td>
<td>.606**</td>
<td>.117</td>
<td>.275</td>
<td>.321</td>
<td>.203</td>
<td>.474**</td>
</tr>
<tr>
<td>Spelling</td>
<td>.842**</td>
<td></td>
<td>.428**</td>
<td>.039</td>
<td>-.029</td>
<td>.570**</td>
<td>.269</td>
<td>.180</td>
</tr>
<tr>
<td>Comprehension</td>
<td>.858**</td>
<td>.749**</td>
<td></td>
<td>.063</td>
<td>.288</td>
<td>.473**</td>
<td>.252</td>
<td>.283</td>
</tr>
<tr>
<td>Non-word</td>
<td>.607**</td>
<td>.553**</td>
<td>.564**</td>
<td>.151</td>
<td>.143</td>
<td>.140</td>
<td>.047</td>
<td></td>
</tr>
<tr>
<td>Phon awareness</td>
<td>.327*</td>
<td>.437**</td>
<td>.253</td>
<td>.188</td>
<td>.331*</td>
<td>.256</td>
<td>.044</td>
<td></td>
</tr>
<tr>
<td>Spoonerism</td>
<td>.535**</td>
<td>.549**</td>
<td>.544**</td>
<td>.644**</td>
<td>.233</td>
<td></td>
<td>.468**</td>
<td>.104</td>
</tr>
<tr>
<td>Word span</td>
<td>.419**</td>
<td>.363**</td>
<td>.518**</td>
<td>.490**</td>
<td>.041</td>
<td>.449**</td>
<td></td>
<td>.078</td>
</tr>
<tr>
<td>Naming speed</td>
<td>-.613**</td>
<td>-.613**</td>
<td>-.505</td>
<td>-.454**</td>
<td>-.437**</td>
<td>-.506**</td>
<td>-.317*</td>
<td></td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

These descriptive analyses are followed by a series of multiple regression analyses. These focused on the phonological predictors of literacy used in the study. Separate analyses were performed for each language cohort and for each measure of literacy. In each case, control variables of age, sex and grade/year were entered into the analysis prior to the phonological predictors. Subsequent stepwise entry of predictors then looked for the best single predictor and combination of predictors.
For the Persian children, only 6% of the variability in word reading was explained by the control variables. Rapid digit naming proved to be the best predictor of variability after these control variables, explaining a further 18% of the variability in word reading. This measure together with the Spoonerisms task and the phonological awareness task increased the level of prediction to 35%. For the reading comprehension measure, 15% of the variability was explained by the control variables, with this time Spoonerisms proving to be the best predictor after the entry of the control variables, increasing the variability explained to 32%. The addition of rapid digit naming increased the variability explained to 35%. Only 9% of the variability in spelling scores was explained by the control variables. Again, the Spoonerisms task was the best predictor after the entry of the control variables, increasing the variability explained to 48%. None of the other variables added to this level of predicted variability.

For the English children, 19% of the variability in word reading was explained by the control variables. Non-word reading proved to be the best predictor of variability after these control variables, explaining a further 25% of the variability in word reading. This measure together with the rapid naming task increased the level of prediction to 55%. However, if non-word reading was not included in the analysis, the Spoonerisms task proved the best predictor of variability, also adding some 25% extra variability explained and increasing the level of prediction to 52% with the rapid naming measure. For reading comprehension, consistent with the Persian data, 16% of the variability was explained by the control variables, with Spoonerisms increasing this variability explained to 41%. The addition of the word span task increased the variability explained to 49%. When spelling was the dependent variable, 18% of the variability was explained by the control variables. Again consistent with the Persian findings, Spoonerisms was the best predictor after the entry of the control variables,
increasing the variability explained to 44%. The addition of rapid naming increased the level of predicted variability to 53%.

**Discussion**

Overall, these data were consistent with the conclusions derived from the study reported in chapter 6. For both Persian and English, measures of phonological processing were predictors of variability in literacy levels when reading and spelling were considered, as well as when reading in and out of context were measured. The more complex phonological task, the Spoonerisms task, which required the use of phonological working memory as well as an awareness of the sounds units within words, proved to be the most predictive of the phonological measures within both cohorts, although rapid digit naming was also a reasonable predictor of literacy variability. Interestingly, once the control variables were accounted for, the regression analyses were fairly consistent in the amount of variability explained by the phonological measures across the Persian and English data, with the possible exception of the comprehension measures, where the English data showed somewhat larger levels of variability explained than the Persian data. However, these findings suggest that predictors of literacy levels in Persian should be relatively similar to predictors of literacy levels used in English. As such, measures used to identify poor literacy acquisition in English may be useful identifiers of the same problems in Persian. The following studies were performed to investigate this specific prediction.

However, there are limitations to this study that need to be noted to caution against over-concluding from these data and also provide a basis for future replication work. The major limitation for cross-language work, which is the same for this study as well as the work of others, is that making measures comparable across languages in every respect is virtually impossible. Hence, there may be confounding variables that lead to errors of interpretations. For example, in the present study, word items may not have been comparable in terms of
frequency of occurrence in the language; although controlling this factor would have been difficult given the lack of Farsi word frequency estimates. The difficulty of finding a non-word reading task that shows variability in performance a more transparent orthography is an example where complexity and orthography interact in a way that makes equivalence across language measures very difficult (see tables 7.2 and 7.3) – the difference in variability on non-word reading scores across Persian and English could be argued as a reason for the correlations between these measures and reading and spelling levels being larger in the English data than the Persian data, for example. Similarly, in the phonological awareness tasks, the Persian version used a measure of sound blending, whereas the English data are derived from a measure of sound deletion. Again, the tasks may not be comparable in terms of level of complexity. Clearly, further research is necessary to determine whether these factors will have led to errors of interpretation in the present work. Although it could be argued that finding commonality in predictors across the two languages would be unlikely to occur due to differences in measures across the language, further research is necessary to confirm this interpretation.

A potentially more plausible alternative explanation for the commonality findings, however, is that the current work did not include areas of functioning that would have led to divergence in predictors. For example, the focus of the work was on phonological areas, meaning that visual processing was not assessed to the same extent. Given the potential complexity of the Persian orthography, it may be that the addition of measures involving complex visual discrimination processes may have led to differences in predictors between Farsi and English (see, for example, Elbeheri et al, 2006, for a similar argument relating to Arabic and English comparisons). In defense of the current work, the tests were developed with speech therapists in mind and the findings should inform future studies in terms of the measures to use and
provide the basis on which more standardized measures can be incorporated into studies. At present, there are no Farsi standardization norms for the areas assessed in this thesis. Hence comparisons between standardized measures in English and Farsi were not possible— and, therefore, the use of standardized measures was not considered vital for the work undertaken (the measures selected were those easily available to the researchers and for which relatively short periods of time were necessary to train testers to conduct pilot work that preceded formal testing). However, this work will provide a basis on which such standardization work can take place, leading to future studies that should be able to include normative data in their comparisons. This should lead to a better understanding of the commonalities across, and of any differences between, Persian and English literacy development.

A further area of limitation in the present work was the selection of children to be tested. Again, cross-country work often leads to the necessity to make compromises in terms of control factors. In the present work, contrasts of Iranian and UK school children mean that either chronological age or years of formal schooling will vary across the group studies. This is because formal schooling for the Iranian cohort starts at age 6 to 7, whereas that for the UK group starts at age 5 to 6. In the present study, data were reported from children across the two countries that had experienced a similar amount of formal schooling. This was considered a more important factor to control than chronological age. However, further work will be needed to ensure that this difference in chronological age across cohorts was not a confounding factor in the study. One way to do this would be to follow groups of English and Persian children across the initial grades of schooling (i.e., a cross-language longitudinal study), contrasting groups at different age and grade points over the period of investigation. This type of study was beyond the available resources of the current work, but would be useful for further theoretical interpretations. In addition to such cross-country differences,
there were also the problems related to the sizes of the samples used in this study. As in the work discussed in the previous chapter, some analyses were conducted on relatively small numbers of children (N=40 in the Persian data set, for example). This means that the regression analyses performed in this study will need to be replicated prior to formal conclusions being made. Again, the finding of commonalities seems more likely robust against this criticism; however, further testing is needed to support this conclusion.
Chapter 8

Dyslexia amongst Persian language children

8.1 Introduction

There is considerable evidence that phonological skills are a significant factor in children successfully developing English word level literacy skills (Adams, 1990; Bryant and Bradley, 1985; Cunningham, 1991; Frith, 1995; Snowling, 2000; Stanovich, 1988). However, there is doubt whether the phonological deficit perspective can account for all of the literacy-related difficulties experienced by children across different language backgrounds. An isolated phonological perspective may not provide a model that will work with the diverse nature of scripts found around the world, where the relationship between sound and graphical representation is completely different to that of English. For example, it has been argued that 50% of Chinese dyslexics do not have a phonological deficit; indeed, Ho (1994) found that visual discrimination skills and visual memory skills (along with phonological awareness) at three years were significant predictors of reading Chinese at four and five years.

Given that the phonological deficit viewpoint was derived from the perspective of dyslexia as a language-related disability, it could be argued that differences across languages would be expected. Similarly, such language-based differences need not be an indication of different underlying cause. The same cause may be responsible for reading difficulties, but its behavioral manifestation may vary across languages. However, without a precise indication of the effect of phonological units on literacy and how these are predicted to vary across language contexts, such variations cast doubt on the universality of the phonological-based perspectives.
The current research aims to inform this area of literacy research by contrasting literacy and phonological measures in children whose first language is Persian. Consistent with other relatively transparent languages (e.g., Italian, Spanish, and German), the mappings between Persian graphemes and phonemes are reliable and children can use this information to sound out unfamiliar words. The regular nature of the language leads to first grade reading instruction being phonic in character. Therefore, it might be expected that it would be easier for children who speak Persian to learn to read and spell. However, despite regular grapheme-phoneme correspondence, there is a one-to-many sound-symbol correspondence leading to a single phoneme potentially being represented by two or more (up to four) different graphemes (Samareh, 1979). Semantically unrelated words may sound identical and lead to problems in spelling isolated words, the ambiguities only being resolved when the words are presented in context. Additionally, the Persian language has only six spoken vowels which are represented in the script in two different ways. Three of these vowels are each represented by a letter of the alphabet. The other three vowels are represented by diacritics. Text in which these diacritics are omitted may provide a major source of reading problems for a beginner reader.

The focus of the research described in this part of the study is to identify how the Persian language/script influences reading and spelling difficulties amongst children with dyslexia, as well as identify potential relationships with phonological processing skills. The rationale for the study was to assess Persian language pupils using a selection of tasks that have been used as part of dyslexia screening assessments and contrast the performance of dyslexic children with matched non-dyslexics. In Iran, dyslexic children can be identified in grades 1 and 2, but difficult to test in higher grades due to the view that appropriate remediation in these early grades will lead to a reduction in literacy problems making further special teaching and
identification unnecessary. Therefore, comparisons focused on these early literacy groups. Measures of literacy assessed word reading and spelling. Words were presented in isolation as well as in connected text to investigate the influence of sentence context on accuracy. Rate of reading was also assessed given previous evidence that speed rather than accuracy may be sensitive to literacy difficulties in relatively more transparent scripts.

To assess the influence of different aspects of phonological processing on literacy ability, measures of awareness, storage and access were included in the study. Measures of awareness required the child to blend, delete and segment sub-word units and specifically focused on phonemic processing. Phonological access was measured by requiring the child to name quickly line drawings of familiar objects, since speeded access has been found to be a reliable discriminator of dyslexic and non-dyslexic individuals learning a relatively transparent script. Finally, measures of short-term storage contrasted verbally presented items with visual presented familiar stimuli in order to contrast auditory and visual short-term memory.

8.2 Method

8.2.1 Participants

Initially, 49 children identified by their school as having dyslexia were considered. All these children were in grade 1 or grade 2. School reports indicated that the majority (over 50%) of these dyslexic pupils had finished their first academic year with no acceptable marks and, therefore, would have to repeat the first year in addition to the supportive training programs provided in the Learning Disability Centre (LDC). School reports indicated that the grade 2 dyslexic pupils had a wide range of weaknesses in reading and writing. Although these children had passed their first year exams, in many cases this was after repeating their first
grade of schooling. Therefore, both grade 1 and 2 dyslexic children presented a background of educational difficulties in the area of literacy and/or general school assessment.

Table 8.1 Ratio of female (f) to male (m) children of dyslexic Persian speaking pupils in grade 1 and 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade</th>
<th>sex</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyslexia (all participants)</td>
<td>One=30, Two=19</td>
<td>Male=20, Female=29</td>
<td>49</td>
</tr>
<tr>
<td>Dyslexia (with complete data)</td>
<td>One=20, Two=16</td>
<td>Male=16, Female=20</td>
<td>36</td>
</tr>
<tr>
<td>Omitted subjects</td>
<td>One=10, Two=3</td>
<td>Male=4, Female=9</td>
<td>13</td>
</tr>
</tbody>
</table>

The focus of the current research was to investigate the specific literacy deficits associated with dyslexia, rather than more general learning difficulties that often accompany low IQ scores. Therefore, in order to control for general learning deficits and allow a comparison with a group of normally functioning control children, children with IQs below the average range were excluded from the current data analyses. Furthermore, due to problems with access to children (due mainly to teaching hours and illness) not all of the children completed all of the tests. Therefore, the initial 49 were reduced to the 36 children with average or better IQ scores for whom data were available on all test measures (see Table 8.1).

These 36 dyslexic children were contrasted with children selected from the previous studies who were educated in the same schools as the dyslexic children and who were in the same...
grades. Control children were selected based on information from school records indicating that they presented no evidence of literacy learning problems and to ensure that as a group they matched the dyslexic group in terms of educational background (school and year). In total, 58 control children were selected for comparison purposes.

Fifty-eight children from grades 1 and 2 were selected from a number of schools across Tehran and used as a control group in this study, in order to ensure that the sample represented a variety of social/educational backgrounds, although all schools in Tehran, regardless of geographical location, use the same curriculum, with all textbooks being exactly the same across schools. Children were selected based on information from school records indicating that they presented no evidence of literacy learning problems and consent of parents and teachers. Roughly half of these non-dyslexic children were male and the other half were female (see Table 8.2). The native language of all the children tested was Persian, and they had no knowledge of any other language. The mean age for grade 1 children was 7 years and for grade 2 children was 8 years (see details in Table 8.2).

Table 8.2 Ratio of female to male children and average ages in months (with standard deviations in brackets) for dyslexics and controls in grades 1 and 2.

<table>
<thead>
<tr>
<th>Male:Female ratio</th>
<th>Age in months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grade 1</td>
</tr>
<tr>
<td></td>
<td>grade 1</td>
</tr>
<tr>
<td>Controls</td>
<td>13f : 15m</td>
</tr>
<tr>
<td></td>
<td>85.14</td>
</tr>
<tr>
<td></td>
<td>(3.41)</td>
</tr>
<tr>
<td>Dyslexics</td>
<td>12f : 8m</td>
</tr>
<tr>
<td></td>
<td>91.50</td>
</tr>
<tr>
<td></td>
<td>(5.22)</td>
</tr>
</tbody>
</table>
Table 8.2 provides background information on ages and male: female ratios for these groups of dyslexic and non-dyslexic children. Analyses indicated a non-significant difference in sex ratios between controls and dyslexics (Chi-square=0.47, df=1, p=.49), but evidence for dyslexics to be older than the controls (F=30, df =1 and 90, p<.001). This latter difference was consistent with most of the dyslexic children taking the first grade of schooling twice due to the educational policy of retaining children in grade 1 if they fail the exams for that grade.

8.2.2 Test materials and procedures

Children were examined individually in a quiet room, away from distractions and other children. The full testing procedure took approximately two hours with a break provided in the middle of the assessment. Test administrators were trained speech and language therapists who were familiar with the test materials and procedures and followed a prescribed/common testing procedure. The measures used in the study assessed phonological awareness skills, rapid naming ability, verbal working memory, oral reading and spelling. Each child performed the tasks in the following order.

Phonological awareness tasks

Three measures of phonological awareness were used. These comprised the tasks that required phoneme blending, phoneme deletion and phoneme segmentation (see also Chapter 5). Each task was preceded by verbal instruction and two practice trials, during which corrective feedback was given.

The phoneme blending task consisted of 10 real target words, two to five letters in length. The tested verbally presented the child with the two or more phonemes that comprised the
target word. Each phoneme was presented individually and separated from the other phonemes by a pause. The child was asked to state the word that the sounds made. For example, the tester would say ‘what word does this produce? /b/, /u/’, and a pause would indicate that a response was required (in this case the word is bu means smell in English). The number of phonemes required to produce the target word was increased over the course of the task from two to five. The number of target words correctly produce was used as the measure for this task.

The phoneme deletion task also consisted of ten real words, varying in length from two to seven letters. The child is verbally presented with a word and asked what would be left if a sound is removed from the word; eg, after practice trials indicating the procedure, the tester would say ‘su rat, r’ (su rat means face in English), with the answer being /su at/. Items ensured that the child had to delete sounds from the initial, middle and end of the word. The number of phonemes within the words was increased during the course of the task and the number of correct responses was used as the measure.

The phoneme segmentation task required the child to tap out the number of phonemes in each word spoken by the tester. Again ten trials were used with items comprising two to five phonemes, two phoneme items being used at the start of the test and increasing to five phoneme items. A mark was given for each phoneme correctly tapped, with the number of correct responses out of a total of 39 being used as the measure in this task.

*Rapid naming task*

Line drawings of five common objects (horse, clock, cars, apple and ball) were presented 10 times each on a sheet of paper producing 50 items in total. The child was asked to name each
of the items on the page starting at the top of the page and working from right to left (as in Persian writing). They were told to name each picture as quickly but as accurately as possible. Familiarity with the pictures was ensured prior to the test. Uncorrected errors were rare in the data, so scores for the task were based primarily on the times taken in seconds to complete the page. A score for the task was derived by taking the number of items named, dividing by the time taken and multiplying by 60 to give the number of naming responses per minute.

Verbal memory tasks

These tasks presented the child with an increasing series of items (words, sentences, pictures or letters) either verbally or visually and asked the child to verbally state the items presented in the order of presentation.

For the words task, 91 three-phoneme, one-syllable words were chosen on the basis of their frequency of occurrence in the children's speech and reading materials. Trials ranged from between two words up to seven, with three trials being available per series length. The tester verbally presented the words, followed by a pause indicating that the child was to verbally repeat the items presented in the correct order. Errors on each of the three trials of a particular series length led to the task being stopped to avoid unnecessary pressure on the children. The number of words in the trial prior to failure at a particular series length was used as a measure of memory span in this task.

In the sentences task, the verbally presented sentences varied in length, grammatical structure and meaningfulness. Seven sentences, each containing a different syntactic structure, were used, with sentences varying in length from 3 to 15 words. If the tester repeated the sentence
twice and the child could not repeat the sentence correctly, the task was terminated to avoid unnecessary pressure. The number of words repeated correctly in the last sentence prior to the task being stopped was used as a measure of memory span in this task.

For the picture task, six sets of pictures were presented to the child, with the number of pictures in each set increasing from two to seven. Following each set of pictures, the child was asked to name the pictures they had just seen in the order of presentation; e.g., if presented with a picture of a flower then a car, their verbal response should be 'flower, car'. As in the previous memory tasks, the number of pictures that comprised in the last correct trial was used as a measure of memory span.

The letters task was identical to the picture task except that sets of letters were presented instead of pictures. The children were visually presented with six sets of letters which increased from two to seven letters. After presentation, the child was required to name the letters in the order of presentation. The number of letters in the last set correctly named was used as the measure of memory span in this task.

*Single word reading*

Two lists of 20 words were sampled from the Iranian elementary school text books. These words were selected to create vary in terms of phoneme complexity and word length. Two lists were used so that the first list of words could be presented with diacritics and the second list without diacritics. Children were asked to read each word aloud. The number of words read correctly in each list was used as the measure for these tasks.
Text reading

A passage of text taken from the grade 1 reading textbooks of the children was presented to the child and they were asked to read it out loud. Errors and speed of reading the passage were recorded. For scoring reading accuracy, the number of reading errors was deduced from the total number of the words in the passage. For reading speed, the number of words divided by the time taken (in seconds) to read the passage was calculated and multiplied by 60 to give the number of words read per minute. Comprehension questions about the passage were also asked of the child with the percentage number correct being recorded.

Single word spelling

Thirty words, selected from grade one and two textbooks, were dictated to the child to measure their ability to spell real words. Words were presented in isolation and increased from one syllable words at the start of the test to five syllable words at the end. After each word was spoken to the children, they were asked to write the word on the paper provided for them. A gap between words was used to allow the children time to write down each item. After all 30 words were presented, the sheet of paper was collected and the number of words correctly spelt was used as the measure for this task.

Spelling dictated text

A familiar passage, as in the case of passage reading taken from the grade 1 reading textbooks of the children, was dictated to the child. The passage was spoken clearly and slowly to allow time for writing. The child was asked to write down on the sheet of paper provided all of the words spoken to them by the tester. After the passage was completed, the sheet was marked for the number of words correctly, which was used as the measure for this task.
8.3 Results

8.3.1 Differences analysis

Average performance of the grade 1 and 2 dyslexics and non-dyslexic children can be found in Table 8.3. Analyses of variance contrasting the performance of dyslexic and non-dyslexic children in grades 1 versus 2 were performed for each variable. The results of these 2x2 analyses can be found in Table 8.4.

Main effects of group (dyslexic versus non-dyslexic) were found for most measures, with the exception of recall tasks involving sentences and objects. In all literacy and most phonological tasks, dyslexics performed worse than controls. However, this group effect interacted with grade in measures of single-word reading and spelling and text reading and spelling (see Figures 8.1 and 8.2). In the case of single-word reading, grade 2 dyslexics were still significantly worse than their peers (reading with marks: $t_{(44)}=4.24$, $p<.001$; reading without marks: $t_{(44)}=3.85$, $p<.001$), but the difference was smaller than that found amongst grade 1 children (reading with marks: $t_{(46)}=6.22$, $p<.001$; reading without marks: $t_{(46)}=7.91$, $p<.001$) — a similar pattern was found for word spelling (grade 1 controls versus dyslexics: $t_{(46)}=7.63$, $p<.001$; grade 2 controls versus dyslexics: $t_{(44)}=3.85$, $p<.001$). In the case of text reading and spelling, grade 2 dyslexics were not significantly worse than the non-dyslexic grade 2 children (text reading accuracy: $t_{(44)}=1.83$, $p=.074$; text spelling: $t_{(44)}=1.50$, $p=.14$) in contrast to the findings amongst grade 1 children (text reading accuracy: $t_{(46)}=4.93$, $p<.001$; text spelling: $t_{(46)}=5.13$, $p<.001$). Despite the potential benefits of contextual clues leading to improved text accuracy amongst grade 2 dyslexics, they still remained comparatively slow text readers.
Table 8.3 Means (with standard deviations in brackets) for each of the measures produced by grade 1 and 2 dyslexic and control children

<table>
<thead>
<tr>
<th></th>
<th>Grade 1</th>
<th></th>
<th>Grade 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Controls</td>
<td>Dyslexics</td>
<td>Controls</td>
<td>Dyslexics</td>
</tr>
<tr>
<td>Word Reading (marked)</td>
<td>16.39</td>
<td>9.20</td>
<td>18.20</td>
<td>14.69</td>
</tr>
<tr>
<td></td>
<td>(2.20)</td>
<td>(5.56)</td>
<td>(1.47)</td>
<td>(4.09)</td>
</tr>
<tr>
<td>Word Reading (unmarked)</td>
<td>14.64</td>
<td>5.72</td>
<td>16.40</td>
<td>13.38</td>
</tr>
<tr>
<td></td>
<td>(3.19)</td>
<td>(4.67)</td>
<td>(1.94)</td>
<td>(3.40)</td>
</tr>
<tr>
<td>Text Reading accuracy</td>
<td>43.36</td>
<td>30.85</td>
<td>43.47</td>
<td>42.62</td>
</tr>
<tr>
<td></td>
<td>(1.06)</td>
<td>(13.43)</td>
<td>(1.53)</td>
<td>(1.41)</td>
</tr>
<tr>
<td>Text Reading rate</td>
<td>73.35</td>
<td>28.20</td>
<td>106.35</td>
<td>55.89</td>
</tr>
<tr>
<td></td>
<td>(25.82)</td>
<td>(28.43)</td>
<td>(31.16)</td>
<td>(17.66)</td>
</tr>
<tr>
<td>Reading comprehension</td>
<td>66.7</td>
<td>49.99</td>
<td>79.44</td>
<td>71.00</td>
</tr>
<tr>
<td></td>
<td>(25.7)</td>
<td>(35.05)</td>
<td>(22.18)</td>
<td>(23.9)</td>
</tr>
<tr>
<td>Word</td>
<td>20.36</td>
<td>9.50</td>
<td>24.97</td>
<td>19.00</td>
</tr>
<tr>
<td></td>
<td>(3.80)</td>
<td>(6.05)</td>
<td>(4.48)</td>
<td>(5.90)</td>
</tr>
<tr>
<td>Text Dictation</td>
<td>43.71</td>
<td>27.70</td>
<td>42.80</td>
<td>39.50</td>
</tr>
<tr>
<td>Spelling</td>
<td>(2.24)</td>
<td>(16.38)</td>
<td>(8.16)</td>
<td>(4.37)</td>
</tr>
<tr>
<td>Phoneme</td>
<td>9.71</td>
<td>5.97</td>
<td>9.07</td>
<td>7.50</td>
</tr>
<tr>
<td>Blending</td>
<td>(0.53)</td>
<td>(2.19)</td>
<td>(1.14)</td>
<td>(2.07)</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>6.64</td>
<td>3.25</td>
<td>5.97</td>
<td>4.75</td>
</tr>
<tr>
<td></td>
<td>(2.23)</td>
<td>(2.75)</td>
<td>(2.19)</td>
<td>(2.27)</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>36.79</td>
<td>33.50</td>
<td>35.63</td>
<td>32.88</td>
</tr>
<tr>
<td></td>
<td>(4.39)</td>
<td>(4.32)</td>
<td>(6.27)</td>
<td>(4.81)</td>
</tr>
<tr>
<td>Rapid Naming</td>
<td>62.15</td>
<td>43.81</td>
<td>63.05</td>
<td>48.17</td>
</tr>
<tr>
<td></td>
<td>(13.19)</td>
<td>(11.64)</td>
<td>(9.85)</td>
<td>(9.12)</td>
</tr>
<tr>
<td>Memory for Words</td>
<td>4.32</td>
<td>3.30</td>
<td>4.43</td>
<td>3.62</td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td>(0.73)</td>
<td>(0.68)</td>
<td>(0.62)</td>
</tr>
<tr>
<td>Memory for Sentences</td>
<td>10.39</td>
<td>10.65</td>
<td>9.60</td>
<td>10.81</td>
</tr>
<tr>
<td></td>
<td>(1.75)</td>
<td>(2.66)</td>
<td>(1.77)</td>
<td>(1.91)</td>
</tr>
<tr>
<td>Memory for Objects</td>
<td>3.89</td>
<td>3.75</td>
<td>4.10</td>
<td>4.44</td>
</tr>
<tr>
<td></td>
<td>(0.88)</td>
<td>(1.07)</td>
<td>(0.71)</td>
<td>(0.73)</td>
</tr>
<tr>
<td>Memory for Letters</td>
<td>4.21</td>
<td>2.95</td>
<td>4.33</td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td>(0.83)</td>
<td>(1.39)</td>
<td>(1.06)</td>
<td>(0.77)</td>
</tr>
</tbody>
</table>
Table 8.4 Results of analyses of variance investigating the effect of grade and group (grade 1 and 2 dyslexic and control children)

<table>
<thead>
<tr>
<th></th>
<th>Main effect of group</th>
<th>Main effect of grade</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Reading (marked)</td>
<td>$F(1,90)=55, p&lt;.001$</td>
<td>$F(1,90)=25, p&lt;.001$</td>
<td>$F(1,90)=6.51, p=.012$</td>
</tr>
<tr>
<td>Word Reading (unmarked)</td>
<td>$F(1,90)=73, p&lt;.001$</td>
<td>$F(1,90)=45, p&lt;.001$</td>
<td>$F(1,90)=18, p&lt;.001$</td>
</tr>
<tr>
<td>Text Reading accuracy</td>
<td>$F(1,90)=25, p&lt;.001$</td>
<td>$F(1,90)=20, p&lt;.001$</td>
<td>$F(1,90)=19, p&lt;.001$</td>
</tr>
<tr>
<td>Text Reading rate</td>
<td>$F(1,90)=68, p&lt;.001$</td>
<td>$F(1,90)=28, p&lt;.001$</td>
<td>$F(1,90)&lt;1$</td>
</tr>
<tr>
<td>Reading comprehension</td>
<td>$F(1,90)=5, p=.030$</td>
<td>$F(1,90)=9, p=.004$</td>
<td>$F(1,90)&lt;1$</td>
</tr>
<tr>
<td>Word Spelling</td>
<td>$F(1,90)=64, p&lt;.001$</td>
<td>$F(1,90)=45, p&lt;.001$</td>
<td>$F(1,90)=5.42, p=.022$</td>
</tr>
<tr>
<td>Text Dictation</td>
<td>$F(1,90)=25, p&lt;.001$</td>
<td>$F(1,90)=7.88, p=.006$</td>
<td>$F(1,90)=11, p=.002$</td>
</tr>
<tr>
<td>Spelling</td>
<td>$F(1,90)=70, p&lt;.001$</td>
<td>$F(1,90)=1.99, p=.161$</td>
<td>$F(1,90)=12, p=.001$</td>
</tr>
<tr>
<td>Phoneme Blending</td>
<td>$F(1,90)=21, p&lt;.001$</td>
<td>$F(1,90)&lt;1$</td>
<td>$F(1,90)=4.75, p=.032$</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>$F(1,90)=7.66, p=.007$</td>
<td>$F(1,90)&lt;1$</td>
<td>$F(1,90)&lt;1$</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>$F(1,90)=48, p&lt;.001$</td>
<td>$F(1,90)=1.21, p=.275$</td>
<td>$F(1,90)&lt;1$</td>
</tr>
<tr>
<td>Rapid Naming</td>
<td>$F(1,90)=38, p&lt;.001$</td>
<td>$F(1,90)=2.18, p=.143$</td>
<td>$F(1,90)&lt;1$</td>
</tr>
<tr>
<td>Memory for Words</td>
<td>$F(1,90)=2.95, p=.089$</td>
<td>$F(1,90)&lt;1$</td>
<td>$F(1,90)=1.25, p=.267$</td>
</tr>
<tr>
<td>Memory for Sentences</td>
<td>$F(1,90)=6.10, p=.015$</td>
<td>$F(1,90)=6.10, p=.015$</td>
<td>$F(1,90)=1.76, p=.188$</td>
</tr>
<tr>
<td>Memory for Objects</td>
<td>$F(1,90)&lt;1$</td>
<td>$F(1,90)&lt;1$</td>
<td>$F(1,90)&lt;1$</td>
</tr>
<tr>
<td>Memory for Letters</td>
<td>$F(1,90)=12, p=.001$</td>
<td>$F(1,90)=7.73, p=.007$</td>
<td>$F(1,90)=5.03, p=.027$</td>
</tr>
</tbody>
</table>
The lack of interaction effects in the measures of phoneme segmentation, rapid naming and word span were also consistent with continued deficits in all of the areas of phonological processing assessed in the study. However, phoneme blending and deletion did show evidence of an interaction between group and grade, with differences between dyslexics and non-dyslexics reducing in grade 2 (phoneme blending: $t_{(44)}=3.33, p=.002$; phoneme deletion: $t_{(44)}=1.77, p=.083$) compared to grade 1 (phoneme blending: $t_{(46)}=8.69, p<.001$; phoneme deletion: $t_{(46)}=4.71, p<.001$) – although there was still evidence of some level of difficulty amongst dyslexics in these phonological measures across both grades (see Figure 8.3).

Similarly to the findings above, short-term memory for visually presented letters showed evidence of improvements in grade 2 (controls versus dyslexics: $t_{(44)}=0.90, p=.373$) compared to grade 1 (controls versus dyslexics: $t_{(46)}=3.93, p<.001$) given the significant interaction effect between group and grade, an effect that was not found for verbally presented words (see Figure 8.4).
Figure 8.1. Word-level literacy measures

Figure 8.2. Text-level accuracy measures
Figure 8.3. Phoneme blending and deletion measures

Figure 8.4. Memory for spoken words and written letters
8.3.2 Correlation between measures

Relationships between measures were investigated for the 36 dyslexic children and the 58 control children. Pearson’s correlation coefficients were calculated between the age of the child and the measures in the study for the two groups – these are presented in Table 8.5. Overall, correlations between age and the reading and spelling measures were similar for the two groups. With the exception of the text spelling tasks, the majority were positive and between $r=.3$ to $r=.5$, suggesting a moderate relationship between age and literacy levels amongst the dyslexics and non-dyslexics. The relationships between age and the memory and phonological processing measures were smaller and less likely to be significant for both groups. The main exception to the similar relationships conclusion was for the phoneme blending task, which showed a significant negative relationship with age for the control group, suggesting that older non-dyslexics performed less well than younger non-dyslexics; although the ceiling effects with this task were suggestive of good performance from an early age.

In addition to relationships with age, inter-relationships between measures were also investigated for each group of children using Pearson’s correlations. Correlations between basic word level text literacy skills and the phonological processing measures are presented in Table 8.6. Tables 8.7 and 8.8 then present the correlations between these same measures and the text level literacy measures.
Table 8.5 Pearson’s Correlation between the measures and age for the dyslexic and non-dyslexic Persian grade 1 and 2 children

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dyslexic age</th>
<th>Control age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoneme Blending</td>
<td>.285</td>
<td>-.408**</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>.128</td>
<td>-.005</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>-.081</td>
<td>-.118</td>
</tr>
<tr>
<td>Rapid Naming</td>
<td>.148</td>
<td>.144</td>
</tr>
<tr>
<td>Memory for Words</td>
<td>-.039</td>
<td>.068</td>
</tr>
<tr>
<td>Memory for Sentences</td>
<td>-.079</td>
<td>-.126</td>
</tr>
<tr>
<td>Memory for Objects</td>
<td>.279</td>
<td>.136</td>
</tr>
<tr>
<td>Memory for Letters</td>
<td>.266</td>
<td>.075</td>
</tr>
<tr>
<td>Word Reading</td>
<td>.381*</td>
<td>.543**</td>
</tr>
<tr>
<td>Word Reading (marked)</td>
<td>.428**</td>
<td>.478**</td>
</tr>
<tr>
<td>Word Reading (unmarked)</td>
<td>.388*</td>
<td>.174</td>
</tr>
<tr>
<td>Text Reading accuracy</td>
<td>.219</td>
<td>312*</td>
</tr>
<tr>
<td>Reading Comprehension</td>
<td>.335*</td>
<td>.486**</td>
</tr>
<tr>
<td>Text Dictation</td>
<td>.416*</td>
<td>.475**</td>
</tr>
</tbody>
</table>

*correlations significant at the 0.05 level (2-tailed).

** correlations significant at the 0.01 level (2-tailed).
Table 8.6 Pearson’s Correlation between basic literacy and phonological processing measures for the dyslexic (upper, right hand area) and non-dyslexic (lower, left hand area) Persian grade 1 and 2 children

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Phon blend</th>
<th>Phon Del</th>
<th>Phon seg</th>
<th>Rapid nam</th>
<th>Read MWr</th>
<th>Read UWr</th>
<th>Dict words</th>
<th>Mem Word</th>
<th>Mem Sent</th>
<th>Mem Obj</th>
<th>Mem Let</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoneme Blending</td>
<td>.486**</td>
<td>.398*</td>
<td>.275</td>
<td>.632**</td>
<td>.564**</td>
<td>.584**</td>
<td>.074</td>
<td>.225</td>
<td>.062</td>
<td>.338*</td>
<td></td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>.125</td>
<td>.407*</td>
<td>.388*</td>
<td>.345*</td>
<td>.395*</td>
<td>.448**</td>
<td>.005</td>
<td>.273</td>
<td>.155</td>
<td>.067</td>
<td></td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>.060</td>
<td>-.036</td>
<td>.315</td>
<td>.306</td>
<td>.212</td>
<td>.319</td>
<td>.014</td>
<td>.265</td>
<td>.095</td>
<td>.216</td>
<td></td>
</tr>
<tr>
<td>Rapid Naming</td>
<td>.092</td>
<td>.079</td>
<td>.146</td>
<td>.307</td>
<td>.235</td>
<td>.417*</td>
<td>.288</td>
<td>.240</td>
<td>.096</td>
<td>.137</td>
<td></td>
</tr>
<tr>
<td>Reading Marked words</td>
<td>-.212</td>
<td>.196</td>
<td>-.107</td>
<td>.294*</td>
<td>.826**</td>
<td>.761**</td>
<td>.064</td>
<td>.222</td>
<td>.075</td>
<td>.326</td>
<td></td>
</tr>
<tr>
<td>Reading Unmarked words</td>
<td>-.150</td>
<td>.221</td>
<td>-.060</td>
<td>.409**</td>
<td>.776**</td>
<td>.854*</td>
<td>.205</td>
<td>.315</td>
<td>.113</td>
<td>.252</td>
<td></td>
</tr>
<tr>
<td>Dictation Words</td>
<td>-.128</td>
<td>.060</td>
<td>.073</td>
<td>.140</td>
<td>.406**</td>
<td>.423**</td>
<td>.130</td>
<td>.272</td>
<td>.132</td>
<td>.330*</td>
<td></td>
</tr>
<tr>
<td>Memory for Words</td>
<td>.166</td>
<td>.190</td>
<td>.172</td>
<td>.246</td>
<td>.174</td>
<td>.173</td>
<td>-.163</td>
<td>.026</td>
<td>.197</td>
<td>.115</td>
<td></td>
</tr>
<tr>
<td>Memory for Sentences</td>
<td>.195</td>
<td>.174</td>
<td>-.026</td>
<td>.009</td>
<td>.069</td>
<td>.034</td>
<td>-.119</td>
<td>.277*</td>
<td>-.045</td>
<td>-.196</td>
<td></td>
</tr>
<tr>
<td>Memory for Objects</td>
<td>.031</td>
<td>-.164</td>
<td>-.027</td>
<td>.229</td>
<td>.170</td>
<td>-.051</td>
<td>.056</td>
<td>-.048</td>
<td>-.001</td>
<td>.117</td>
<td></td>
</tr>
<tr>
<td>Memory for Letters</td>
<td>.228</td>
<td>.297*</td>
<td>.079</td>
<td>.327*</td>
<td>.218</td>
<td>.200</td>
<td>.270*</td>
<td>.024</td>
<td>.172</td>
<td>.280*</td>
<td></td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2 tailed)
Table 8.7 Pearson's Correlation between text-based literacy and phonological processing measures for the dyslexic Persian grade 1 and 2 children

<table>
<thead>
<tr>
<th>Variables</th>
<th>Text reading accuracy</th>
<th>Text reading rate</th>
<th>Text reading comp</th>
<th>Text spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoneme Blending</td>
<td>.634**</td>
<td>.659**</td>
<td>.521**</td>
<td>.547**</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>.251</td>
<td>.606**</td>
<td>.207</td>
<td>.305</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>.223</td>
<td>.302</td>
<td>.256</td>
<td>.363*</td>
</tr>
<tr>
<td>Rapid Naming</td>
<td>.235</td>
<td>.306</td>
<td>.252</td>
<td>.407**</td>
</tr>
<tr>
<td>Memory for Words</td>
<td>.132</td>
<td>.023</td>
<td>.240</td>
<td>.250</td>
</tr>
<tr>
<td>Memory for Sentences</td>
<td>.155</td>
<td>.145</td>
<td>.367*</td>
<td>.255</td>
</tr>
<tr>
<td>Memory for Objects</td>
<td>.127</td>
<td>.143</td>
<td>.082</td>
<td>.119</td>
</tr>
<tr>
<td>Memory for Letters</td>
<td>.480**</td>
<td>.234</td>
<td>.374**</td>
<td>.411**</td>
</tr>
<tr>
<td>Word Reading (marked)</td>
<td>.718**</td>
<td>.759**</td>
<td>.647**</td>
<td>.736**</td>
</tr>
<tr>
<td>Word Reading (unmarked)</td>
<td>.757**</td>
<td>.686**</td>
<td>.734**</td>
<td>.794**</td>
</tr>
<tr>
<td>Word Spelling</td>
<td>.802**</td>
<td>.721**</td>
<td>.766**</td>
<td>.816**</td>
</tr>
</tbody>
</table>

*correlations significant at the 0.05 level (2-tailed).

**correlations significant at the 0.01 level (2-tailed).
Table 8.8 Pearson's Correlation between text-based literacy and phonological processing measures for the non-dyslexic Persian grade 1 and 2 children

<table>
<thead>
<tr>
<th>Variables</th>
<th>Text reading accuracy</th>
<th>Text reading rate</th>
<th>Text reading comp</th>
<th>Text spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoneme Blending</td>
<td>-.136</td>
<td>-.196</td>
<td>-.047</td>
<td>-.017</td>
</tr>
<tr>
<td>Phoneme Deletion</td>
<td>.204</td>
<td>.092</td>
<td>-.181</td>
<td>.126</td>
</tr>
<tr>
<td>Phoneme Segmentation</td>
<td>-.075</td>
<td>.071</td>
<td>.120</td>
<td>-.099</td>
</tr>
<tr>
<td>Rapid Naming</td>
<td>.153</td>
<td>.276*</td>
<td>.123</td>
<td>.076</td>
</tr>
<tr>
<td>Memory for Words</td>
<td>.125</td>
<td>.136</td>
<td>.160</td>
<td>-.165</td>
</tr>
<tr>
<td>Memory for Sentences</td>
<td>.076</td>
<td>.027</td>
<td>.042</td>
<td>.017</td>
</tr>
<tr>
<td>Memory for Objects</td>
<td>.045</td>
<td>.054</td>
<td>.240</td>
<td>.126</td>
</tr>
<tr>
<td>Memory for Letters</td>
<td>.215</td>
<td>.285*</td>
<td>.183</td>
<td>.228</td>
</tr>
<tr>
<td>Word Reading (marked)</td>
<td>.454**</td>
<td>.575**</td>
<td>.188</td>
<td>.117</td>
</tr>
<tr>
<td>Word Reading (unmarked)</td>
<td>.412**</td>
<td>.663**</td>
<td>.149</td>
<td>.063</td>
</tr>
<tr>
<td>Word Spelling</td>
<td>.262*</td>
<td>.352**</td>
<td>.331**</td>
<td>.123</td>
</tr>
</tbody>
</table>

*correlations significant at the 0.05 level (2-tailed).

** correlations significant at the 0.01 level (2-tailed).

Overall, the results for the dyslexics indicate relationships between the phonological and single word literacy measures consistent with the dyslexic children with the better phonological skills being the better readers and spellers at the word level. This relationship was less apparent for the control group where age seems to be a much better indicator of literacy levels amongst these children.

152
8.4 Discussion

Overall, the dyslexic children showed evidence of poor literacy, phonological and verbal memory skills in comparison to their non-dyslexic peers. These differences were particularly evident in single-word reading and spelling and text reading speed; although improvements were evident when connected text was used and accuracy was the measure of performance. This specific deficit in reading speed was consistent with the deficits found in rapid naming.

Additionally, phonological processing remained a problem for the dyslexics across both grades 1 and 2, although there was evidence of improvement in skills across these grades. Similarly, memory for visually presented familiar objects or contextually constrained sentences did not show the same differences between dyslexics and non-dyslexics evident when verbally presented words were used, and visually presented letters showed differential improvements in memory for dyslexic children over the grades assessed.

These findings are consistent with those of other language cohorts. Studies of dyslexia in English speaking cohorts provide evidence for deficits in literacy (particularly at the word level), phonological awareness, rapid naming and verbal memory. These same areas of deficit have been identified in this Persian speaking cohort. Such profiles have been used as evidence for the view that dyslexics’ have difficulties that focus around phonological processing deficits (Snowling, 2000; Stanovich, 1988). The findings from these Persian data suggest that the same deficit may be an underlying cause of dyslexia in this language. Similar conclusions have been derived from studies of English/Persian bilinguals (Gholamain & Geva, 1999) and of good and poor Arabic readers (Abu-Rabia, Share & Mansour, 2003). Gholamain & Geva (1999) assessed
the basic reading skills of Persian-speaking Canadian children and found that verbal working memory and rapid naming measures predicted reading development in both English and Persian. Abu-Rabia et al (2003) compared good and disabled Arabic readers and found that processes that lead to a recognition of sounds within words and their relationship to the alphabet were good predictors of variability in ability (see also Elbeheri & Everatt, 2007). The evidence from the present study of Persian dyslexic children, showing a correspondence between weak literacy skills and poor phonological ability, adds evidence for the generality of the phonological processing deficit viewpoint derived from studies across very different language/scripts.

However, the Persian children tested in this study also showed variable improvements on measures of phonological awareness. The phoneme segmentation task seemed to reach ceiling levels, whereby there was no evidence of improvements across grades 1 and 2. This is consistent with initial teaching procedures in the schools where testing occurred that emphasised word segmentation skills as part of literacy acquisition. The regular nature of the Persian orthography in its vowelized form allows children to focus effectively on word decoding skills as part of early literacy learning. However, despite evidence of ceiling effects and the relatively older age of the dyslexic group, some dyslexics still showed problems even with this relatively easy phonological task. Further problems in phonological awareness were identified in the measures of phoneme blending and deletion. Both these measures did show evidence of relative improvements with grade amongst the dyslexics, probably related to specific extra support that they were receiving that focused on dyslexia-related literacy difficulties; however, again there was evidence of phonological problems across both grades. Phoneme deletion was the hardest task for both groups and may be a measure where further differentiation across higher grades can be achieved.
Such findings support research evidence which suggests that certain phonological tasks may be much more predictive of reading ability than other phonological tasks (Duncan, Seymour & Hill, 1997; Muter, Hulme, Snowling & Taylor, 1998), particularly over different grade/reading levels.

Phonological ability may vary with development so that some measures of phonological ability would not be sensitive enough for use with all cohorts of children. A longitudinal study by Scarborough (1990) provides support for the hypothesis that predictors of literacy development change with age. Between two and three years of age, children who later developed reading disabilities were deficient in language skills related to pronunciation accuracy, receptive vocabulary and object-naming abilities. By five years old, these same children exhibited weaknesses in object naming, phonemic awareness and letter-sound knowledge. Furthermore, Liberman, Shankweiler, Fischer & Carter (1974) present evidence for the development of syllable-level to phoneme-level processing skills between nursery and the end of grade one. In this study, the youngest children were able to segment by syllables, but none could segment by phonemes until the end of the first grade when only about 46% could perform at the phoneme level of analysis. Such results question the use of the same test items across the whole of this age range.

Similar variability was identified across measures of short-term recall. The dyslexics showed specific deficits in tasks where isolated words were verbally presented, but less so when presentation was visual. One study that has found a link between deficits in memory and specific learning difficulties was that of Jeffries & Everatt (2003). They tested adults with dyslexia or dyspraxia and compared their performance on measures designed to assess the functioning of the
phonological loop and visuo-spatial scratch pad with a control group of adults with no known learning difficulties. Results indicated that dyslexics showed deficits in recall tasks involving the phonological loop, whereas dyspraxics showed deficits in tasks involving the visuo-spatial scratch pad. Both groups showed good retention ability in tasks that used the working memory sub-system that was not associated with deficits. Such a contrast between verbal and visual presentation may be consistent across both English and Persian cohorts, with dyslexics in both languages showing relatively good performance when items are visually based, but relatively weaker abilities when items are verbally presented.

However, this visual-verbal distinction needs to be treated cautiously in the current sample. Visual skills were not assessed formally to the level that would support strong conclusions about their lack of effect. For example, it could be that differences would be found between dyslexic and non-dyslexic Persian speaking children if visual discrimination processes had been measured or more complex visual memory tasks had been used. Further work may want to consider the inclusion of such tasks. In addition, when verbally presented sentences were used there was less of a difference between dyslexics and non-dyslexics than found for isolated words. This may be related to sentence context supporting the retention of information by these dyslexic children. Indeed, literacy skills varied somewhat depending on whether words were presented in isolation or in connected text. Dyslexics continued to show deficits across both grades in reading and spelling accuracy when isolated words were used, but showed fewer problems of accuracy when connected text was used. Evidence which supports the view that decoding from surrounding contextual information is greater amongst dyslexics than non-dyslexics has been identified in the work of Nation & Snowling (1998) with English-language dyslexics, leading many practitioners
to conclude that dyslexia is evident at the level of the single word (eg, see British Psychological Society, 1999). However, this needs to be considered in terms of different ways of measuring literacy. The Persian dyslexics in this study did show deficits in reading connected text; however, those deficits were evident in rate of reading rather than reading accuracy. This dissociation between accuracy and speed has also been identified in other regular texts (eg, Wimmer, 1993) and is consistent with the poor rapid naming speeds presented by the children in the present study. Hence, connected text, as well as a more transparent orthography, may support accuracy, but deficits may still be evident in rate of processing text.

In this study, dyslexics were identified based on IQ-achievement discrepancy criterion. However, there is controversy as to the value of this procedure (see the special issue of Dyslexia 1996).

Future research may want to contrast high IQ vs. low IQ poor readers in Persian to assess this controversy.

Overall, these findings provide support for the view that dyslexia is a similar phenomenon across Persian and English language cohorts and argues for relating poor literacy to phonological deficits in both languages, despite their differences in orthography. Further work, of course, is necessary to support this conclusion and overcome some of the limitations of the present research (the incorporation of more complex measures that avoid ceiling effects and the assessment of additional areas of processing, such as visual skills, are examples already covered in discussion sections of this thesis); however, the data argue for commonalities across the two languages that should support the development of dyslexia tools in Persian based on those used in English. This proposal will be considered further in the next chapter.
Chapter 9

Dyslexia in Persian versus English

9.1 Introduction

In this final data chapter, a comparison is made of the differences found between Persian dyslexic and non-dyslexic children in the last chapter and groups of dyslexic and non-dyslexic English speaking children. The aim of this comparison is to provide further evidence for the prediction that assessments of dyslexia, derived from English language studies, would be appropriate as a basis for developing specific dyslexia assessments in Persian. Clearly, direct comparisons of dyslexia in the two languages is not possible, given that assessment procedures differ across the two countries. In particular, the typical point of assessment of dyslexia varies between the educational systems. In Iran, dyslexia is diagnosed in the early grades, and intervention in these early grades leads to the view that dyslexia is not a concern from grade 3 onwards. In the UK, dyslexia is usually identified after several years of literacy learning, with year 3 normally being the earliest point at which a formal assessment of dyslexia is made. Hence, the most obvious difference between these assessment practices is the point at which the assessment is conducted. However, despite these differences, divergence between dyslexic and non-dyslexic performance within the two languages can be used to provide evidence for or against common underlying factors that are related to dyslexia in the two languages. The present chapter, therefore, contrasts dyslexics and matched non-dyslexics in the Persian language (i.e., the grade 2 children reported in the previous chapter) with similarly matched groups of year 3
9.2 Method

Given that details of the Persian children and measures have already been reported in the last chapter, the current method section will focus on a description of the English language children and testing procedures. However, reference will be made to the Persian procedures where necessary.

9.2.1 Participants

Forty-eight English speaking year 3 children were tested. All were being educated in mainstream government run schools in and around London. Interviews with teachers and questionnaires given to parents as part of informed consent procedures indicated that all children in this sample were first language English speakers and did not speak another language. Of these 48 children, 23 were identified as having special educational needs and had a formal assessment of dyslexia. Special provisions for these children meant that they were taught for part of their day (either during the school day or following formal lessons) within special units within the schools they were attending. In the main, these additional lessons concentrated on supporting the acquisition of literacy.

Only those children with a full assessment of dyslexia by a trained educational psychologist were selected. Interviews with educational psychologists indicated that a diagnosis of dyslexia was based typically on weak literacy acquisition accompanied by average range general ability
(based on IQ); this been considered as evidence of specific rather than general deficits. These 23 dyslexics were on average 100 months old, and approximately 50% (12 children) were male. These age and sex ratio values were part of the selection criteria for the English sample and ensured that this dyslexic group was similar to the Persian grade 2 dyslexics (age 103 months, 50% male). Comparisons between the grade 2 Persian children from the previous chapter and the year 3 English children can be found in Table 9.1.

The remaining 25 children were selected based on school records and teacher interviews indicating that they presented no evidence of special needs. These English control children were selected from the same schools as the English dyslexic children, and were matched as closely as possible with the English dyslexic group in terms of average age and sex ratio (see Table 9.1).

Table 9.1 English year 3 and Persian grade 2 dyslexic and control children average ages (with standard deviations in brackets) and sex ratio.

<table>
<thead>
<tr>
<th></th>
<th>English year 3</th>
<th>Persian grade 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dyslexic</td>
<td>Control</td>
</tr>
<tr>
<td>Sex ratio</td>
<td>12 to 11</td>
<td>13 to 12</td>
</tr>
<tr>
<td>(male to female)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age in months</td>
<td>99.82 (4.02)</td>
<td>98.89 (4.29)</td>
</tr>
</tbody>
</table>
9.2.2 Design and Measures

The specific aim of this data collection process was to test groups of English language dyslexic and non-dyslexic children, comparable to the grade 2 Persian children reported in the last chapter, on a range of measures that were appropriate for the English language sample, but which could be contrasted with measures used to distinguish the Persian dyslexic and non-dyslexic children. Therefore, the English children were tested on a series of typically assessment measures appropriate for English language children, which were selected to assess the same underlying abilities as tests given to the Persian grade 2 children. These English language measures are described below, with reference being made to the Persian language measures with which they were deemed comparable.

**Word reading**

An English language single word reading measure was developed based on the words used in the Schonell Single Word Graded Reading test (Schonell & Schonell, 1956). The initial 60 words from the Schonell were selected as covering the range from beginning reading to beyond the level of reading expected of UK year 3 children. Testing began with the tester explaining to the child that they would be shown some words and that they were to try to read each word out loud and clearly to the tester. Words were presented on card with 5 words per card, with groups of words increasing in difficulty based on expected familiarity. If a child failed to read all of the five word on a card, testing was stopped. No time pressure was placed on the children in this test, and the number of words read correctly was used as the measures for this task.
This task was selected as a word reading accuracy measure that would be typical of the sort of reading measures used in an English school system, and as being comparable to the word reading measures used with the Persian children. However, whether this English word reading measure should be contrasted with the marked or unmarked versions of the Persian reading measures is debatable. Marked Persian words can be read via a simple grapheme-phoneme conversion process, whereas unmarked Persian words and many English words cannot. Therefore, the following non-word reading measure was incorporated into the English testing battery since this was more likely to force the English children to use grapheme-phoneme conversion rules, which may be more comparable to reading marked Persian words.

**Non-word reading**

A non-word reading measures was developed specifically for this study. It comprised 15 non-words that were derived from real words by changing a letter within the word to produce a pronounceable letter string that did not have a meaning in the English language. The first 8 items were derived from one syllable words and correct pronunciation based on English grapheme-phoneme conversion rules would produce a one syllable response. The remaining items were manipulated in the same way to produce two syllable responses. Children were informed that they would be given a series of new words to read and were asked to read these out loud to the tester. As with the word reading measure, non-words were presented on card in groups of five. To ensure that the child understood the task, a pre-test card of 5 one syllable non-words was used with feedback been given by the tester. The number of non-words read correctly, based on appropriate grapheme-phoneme translation or analogy with another English word, was used as the measure for this task.
This task was used in conjunction with the English word reading measure to provide two tasks against which to contrast the results of the marked and unmarked reading measures in the Persian data set.

Text reading

A passage of text, 50 words in length, was produced for this task. It was based on the type of reading literature used in the schools where testing was conducted and comprised words and themes that should be familiar to the year group tested in the study. Children were asked to read the passage out loud to the tester who recorded any reading errors and the time taken to read the passage. To ensure that the passage was understood by the children, five comprehension questions were asked following the reading of the passage. A brief practice passage was used to explain the procedure to the child.

This task was designed to be similar to the Persian passage reading task used in the previous chapter. Consistent with the Persian data, the measures for this English version were reading accuracy, based on the number of words read correctly out of 50, and reading rate, based on the time taken to read the passage and recorded as words per minute.

Word spelling

This test was used as an analogous task to the word spelling test used with the Persian children. In this English version, the child was verbally presented with 40 individual words that they were required to write on the piece of paper provided. Words were selected to provide a range from
early spelling ability to beyond year 4. The spellings of the child were monitored by the tester and testing was stopped if the child did not attempt 5 words in a row or made five consecutive spelling errors. The score for the task was the number of words spelt correctly out of 40.

**Word span**

This task was treated as analogous to the word memory task used with the Persian children. A set of one syllable English words, familiar to the typical year 3 child, was selected for this task and randomly assigned to series of words from two to seven words in length. The child was told that a group of words would be spoken to them and that they were to try to remember the words in the order they were presented. Practice with two word series was then given and feedback or further instruction provided when necessary. Once the child had repeated correctly 2 two words series, the tester moved on to three word series and further feedback/advice was not given. The tester said each word clearly to the child and nodded to indicate that a response was required. The tester marked whether the child repeated the series correctly or not. After every three series of a given length, the number of words in a series increased by one up to a maximum of seven. If all three items of a given series were repeated incorrectly, testing was stopped. The series length prior to failures on all items of a given series length was used as a measure of the child's span up to the maximum of seven.

**Phonological awareness**

This task comprised three practice and ten test items. For each item, the child was verbally presented with a word and asked to say what would be left it part of the word were missing. The practice items asked what would be left if 'ball' were missing from 'football'. Help was provided
if the child did not understand. The next practice items asked what would be left if 'd' were missing from 'dog', and 't' was missing from 'cat'. Again help was provided for each of these examples. Once the child understood the task, 10 items were presented one at a time which required the child to delete one sound from the word and produce the remaining sound. Individual phonemes that had to be deleted occurred at the beginning ('c' from 'comb'), end ('l' from 'snail') or within ('s' from 'last') the word. The number of items correctly produced by the child was used as the score for this task.

This task was used as analogous to the phoneme deletion task used with the Persian children. This task was selected since the phoneme deletion task failed to show evidence of ceiling effects within the Persian grade 2 data and hence was the most likely to predict variability in literacy performance.

**Rapid naming**

Consistent with the development of the Persian rapid naming task, the English rapid naming measure was based on the Phonological Assessment Battery (Frederickson, Frith & Reason, 1996). It comprised 50 items presented in a 5X10 array on a single sheet of A4 paper. The 50 items were made up of 5 line drawings of familiar objects (ball, hat, door, clock and hand) each of which was presented 10 times. A pseudo-random order was used which ensured that each instance of an item was followed by a different object name. The children were initially familiarized with the 5 line drawings and the tester asked them to say the names of the items. If there was any confusion about the names of the objects (eg, saying glove for the hand line drawing), the tester was instructed to explain that the object was a hand and point out part of the
object that distinguished the line drawing from the object named by the child (e.g., the representation of nails on the drawing). Once the child was able to name all line drawings with the correct name, they were asked to name the array of 50 items as quickly as possible, avoiding mistakes and starting from the left hand side of the top row, moving from left to right and down the rows until they finished at the bottom right hand side of the page. Timing started as soon as the child named the first item, and ended when they named the last. Errors were noted, but there were few uncorrected errors in the data set and hence these were not considered further.

9.3 Results

The data from the English cohort were analysed to look for differences between the dyslexics and non-dyslexics on the measures used. On each measure, the dyslexics performed worse than the control children. Average scores, together with the results of independent samples t-tests comparing the groups are presented in Table 9.2. These findings are comparable to those in the previous chapter for the Persian data, with the exception that in the text reading accuracy measure, the current English cohort showed significant differences, whereas the grade 2 Persian comparison did not. For ease of comparison between Persian and English data sets, effects sizes are presented in Table 9.3. These were calculated by taking the difference between the control and dyslexic groups within each cohort, then dividing this difference by the standard deviation of the respective control group. In this way, the number of control standard deviations that the dyslexics differ from their peers can be contrasted across the two language cohorts.
Table 9.2 Means (with standard deviations in brackets) for each of the measures produced by Dyslexic and control English speaking children

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Control</th>
<th>Dyslexic</th>
<th>t-test (df=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word reading</td>
<td>31.76 (7.24)</td>
<td>17.91 (8.09)</td>
<td>t=6.26 p&lt;.001</td>
</tr>
<tr>
<td>Non-word reading</td>
<td>10.24 (3.92)</td>
<td>5.52 (4.31)</td>
<td>t=3.98 p&lt;.001</td>
</tr>
<tr>
<td>Text reading accuracy</td>
<td>49.12 (1.51)</td>
<td>47.13 (3.17)</td>
<td>t=2.82 p=.007</td>
</tr>
<tr>
<td>Text reading rate</td>
<td>112.68 (25.77)</td>
<td>63.44 (25.48)</td>
<td>t=6.46 p&lt;.001</td>
</tr>
<tr>
<td>Word spelling</td>
<td>24.32 (6.45)</td>
<td>15.48 (6.35)</td>
<td>t=4.78 p&lt;.001</td>
</tr>
<tr>
<td>Phonological awareness</td>
<td>7.00 (1.35)</td>
<td>5.87 (2.07)</td>
<td>t=2.25 p=.03</td>
</tr>
<tr>
<td>Word span</td>
<td>5.36 (0.95)</td>
<td>4.70 (1.36)</td>
<td>t=1.97 p=.05</td>
</tr>
<tr>
<td>Rapid naming</td>
<td>56.92 (11.55)</td>
<td>46.44 (13.56)</td>
<td>t=2.89 p=.006</td>
</tr>
</tbody>
</table>
Table 9.3  Effect sizes for the dyslexic/non-dyslexic comparisons in the Persian and English language cohorts

<table>
<thead>
<tr>
<th>Variables</th>
<th>Persian grade 2 children</th>
<th>Variables</th>
<th>English year 3 children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmarked Word reading</td>
<td>1.56</td>
<td>Word reading</td>
<td>1.91</td>
</tr>
<tr>
<td>Marked Word reading</td>
<td>2.39</td>
<td>Non-word reading</td>
<td>1.20</td>
</tr>
<tr>
<td>Text reading accuracy</td>
<td>0.54</td>
<td>Text reading accuracy</td>
<td>1.32</td>
</tr>
<tr>
<td>Text reading rate</td>
<td>1.62</td>
<td>Text reading rate</td>
<td>1.91</td>
</tr>
<tr>
<td>Word Spelling</td>
<td>1.33</td>
<td>Word spelling</td>
<td>1.37</td>
</tr>
<tr>
<td>Phonological awareness</td>
<td>0.56</td>
<td>Phonological awareness</td>
<td>0.84</td>
</tr>
<tr>
<td>Memory span</td>
<td>1.19</td>
<td>Memory span</td>
<td>0.69</td>
</tr>
<tr>
<td>Rapid naming</td>
<td>1.51</td>
<td>Rapid naming</td>
<td>0.91</td>
</tr>
</tbody>
</table>
9.4 Discussion

The data for the English dyslexic/non-dyslexic comparison was consistent with the data for the Persian dyslexic/non-dyslexic comparisons reported in the last chapter. Deficits were found amongst both cohorts of dyslexics, in comparison to their matched peers, on most of the measures of literacy and phonological processing used. Effect sizes were also comparable across the two cohorts despite the differences in assessment practices used in Iran and the UK. An exception to these general conclusions was that text reading accuracy was found to be relatively good amongst grade 2 Persian children when familiar text was used, whereas familiar text still presented difficulties in terms of reading accuracy for the English dyslexics despite their extra year of formal learning. However, both groups showed evidence of slow rates of reading with such familiar text, suggesting that appropriate measures of literacy performance would identify similar weaknesses.

Another potential exception from the general conclusions derived above was that the Persian dyslexics showed particular weaknesses in reading marked isolated words, which may be due to good levels of performance amongst the control sample, but may also suggest a specific weakness when decoding strategies can support word reading. Consistent with this interpretation, the Persian dyslexics showed weaknesses in all areas of phonological processing, consistent with the data for the English dyslexics and more in line with the deficits found for a relatively non-transparent orthography. However, the marked word reading weakness seems to be larger than that presented by the English dyslexics in the non-word reading measure, which has also been considered to require a decoding strategy. Such effects of diacritic marking seem worthy of further investigation.
Despite these differences, the findings of this chapter are consistent with the conclusion of the previous chapters that measures derived from English language studies should be appropriate for Persian dyslexia assessment, given appropriate translation. Page 162, end of section, after last line, continue same paragraph

It also avoided some of the limitations of previous studies in this thesis. In this study, measures were more closely matched across cohorts. For example, the same type of phonological awareness task was used for Persian and English cohorts, unlike in the study reported in chapter 7, and hence more direct comparisons of effect sizes across cohorts seem justified. However, there are still limitations that need to be considered further. The cautious conclusion derived from the comparison of non-word reading in English and marked word reading in Persian would benefit from further work involving measures that better assess phonological decoding and orthographic reading strategies across the two cohorts. Also, as in previous studies of Persian, the lack of availability of non-standardized tests means that caution in interpretation is required. Although consistency in the studies reported in this thesis allowed for comparisons across data sets, it may have lead to problems due to poor test reliability. Hence, the focus of the present discussion has been on those conclusions derived from more consistent findings — these will be covered further in the general discussion contained in the next chapter. Similarly, the order of task presentation was kept more-or-less consistent across participants — following a set format that a typical dyslexia assessment protocol would use. However, although consistency can be useful in reducing error variance caused by vastly different practice/boredom effects across measures, there is the negative consequence that order effects might interact with groups, leading
to some tasks being performed atypically better in one group compared to the other. Clearly, further work needs to consider such limitations in measurement processes.

However, probably the most obvious limitations in the present study were those related to participant selection. As with much of the work on dyslexia, sample sizes were relatively small. Stronger conclusions should be derived when more data are provided from future work. In addition, the cross-language groups differed in terms of dyslexia assessment processes, which meant that the Persian dyslexics had received less formal schooling than the English dyslexics. It could be that comparisons of effect sizes would have led to different conclusions had, for example, the Persian cohort received an extra year of formal schooling. The difference between dyslexic and non-dyslexic Persian speaking children may have been greater as the dyslexics may have had more time to fall further behind their peers. Alternatively, the difference between Persian dyslexics and non-dyslexics may have been smaller, as the dyslexics may have had another year to catch up. On the other hand, because they were identified earlier than their UK counterparts, the Persian speaking dyslexics had received more specific dyslexia-related intervention opportunity than the English speaking dyslexics. This may have reduced dyslexic/non-dyslexic differences in the Persian cohort in comparison to the English cohort. Additionally, the ways in which identification was undertaken varied across the different countries. At the time of testing, the Iranian system focused on difficulties with learning a phonics-based literacy programme that were not related to low IQ levels. The UK system at the time of testing did not focus on problems with phonics learning and the use of IQ-literacy discrepancy assessments was controversial and inconsistently applied (see the special issues of the journal Dyslexia, 1997, for a discussion of this controversy). Hence, the two cohorts of
dyslexics may have differed in a way that may have biased the results. As with previous problems with the work reported in this thesis, though, it seems unlikely that differences would have led to consistency of effects; however, further work is needed to corroborate the conclusions derived.
Chapter 10

General discussion

10.1 Overview of findings

The results of the first study (reported in the Developmental section of this thesis) indicated good rates of growth in the literacy measures used. Word reading reached high levels of performance (greater than 90% accuracy) by grade 2 for words with diacritic marks (ie, relatively transparent form) and by grade 3 for unmarked words (relatively opaque form) in the first part of the study; although the more complex words used in the second part showed that word reading accuracy can still show variability in performance even by grade 5. Text reading accuracy was well into the 90% range even by grade 1, even for the more complex (potentially less familiar) texts presented to the children; although a relationship between text reading accuracy and isolated word reading was evident in the regression analyses involving all five grades when age and grade were controlled. Consistent with the unmarked word reading scores, text reading comprehension reached ceiling levels (about 90% correct) for most texts, except the text used in the second part of this study, by grade 3. These data suggested a link between unmarked word reading accuracy and text reading comprehension in terms of a developmental progression; although once age/grade were controlled, both reading unmarked words and text comprehension were more likely to be predicted by measures of memory span for the five grade analyses or by Spoonerisms and speed of reading in the analyses involving more complex measures of literacy and phonological processing. Text reading rate, however, continued to improve across all 5 grades (except for passage 3 in the first part of the study), and this was consistent with improvements in word reading speed showed in the second part of the study. Typically, reading
rate was predicted by reading accuracy (isolated unmarked words, across most analyses) once age/grade were controlled in the regression analyses.

The spelling tasks seemed to show a similar pattern of results to the reading measures. When text dictation was used, a high level of performance was reached by grade 2, whereas isolated word spelling showed more variability in performance even at the higher grades. Isolated word spelling, together with isolated unmarked word reading, also showed the largest correlations with age/grade in the first part of the study. Similarly, consistent with the regression analysis involving the isolated unmarked word reading measure, spelling was predicted primarily by measures of memory span in the five grade analyses and by Spoonerisms in the three grade analyses, once age/grade were controlled.

Phonological processing also showed some evidence of developmental trends in this study, although phoneme blending and segmentation showed ceiling effects consistent with good levels of phonological skills been reached early in literacy acquisition - these skills been at a relatively high level even amongst grade 1 children. Phoneme deletion in the first part of the study, and the more complex phonological tasks in the second part of the study, indicated that development of phonological processing skills could still be detected within this cohort of children; the Spoonerisms task of the second part of the study, in particular, showed high levels of variability even amongst grade 5 children. The variability in performance on the Spoonerism task also provided one of the best predictors of variability in literacy scores in the regression analyses when age and grade were controlled. Children with good phonological manipulation skills showed a tendency to possess good word reading and spelling accuracy. However, the level of
variability found in the more complex phonological tasks was not matched in the non-word reading task, which showed both a high level of accuracy and consistent rates across grades 3 to 5. Although more complex phonological tasks were still showing improvements in phonological skills by grade 5, and were predictive of literacy levels, decoding ability seemed at a high level by grade 3 and was not related to literacy.

The naming speed tasks also showed some evidence for improvements with grade level in the ability to rapidly access familiar phonological forms. Although, typically, such improvements were smaller than the variability shown by individual children within the grades, small but significant correlations, which were relatively consistent across the two parts of this study, were found between grade/age and rapid naming. A similar pattern of improvements were shown in the memory span measures, particularly after grade 3. Overall, improvements in memory tasks across age/grades were evident; however, in most tasks, improvements were relatively small compared to variability between individual children. Such improvements in memory tasks, though, did lead to some level of prediction of literacy measures in the five grade regression analyses when age/grade were controlled, although this was not evident in the analyses using more complex phonological processing measures and the level of prediction provided by the memory span measures in the first part of the study was much less than that provided by the Spoonerisms task in the second part of the study.

Comparisons of grade/year 3 and 4 Persian and English speaking children learning to read and write in their home language seem to confirm the importance of the complex phonological manipulation task in predicting variability in literacy. This study found that the main predictor of variance in most measures of literacy across both language cohorts was the Spoonerisms task.
Scores on the Spoonerism task were entered into the stepwise regression procedure, following control variables, for all measures of literacy except reading accuracy, which was the only measure to show clear differences in these analyses between the language groups. In the case of Persian, rapid naming proved to be the best predictor of reading accuracy following the control variables, whereas for the English speaking children, nonword reading was the best predictor of English reading accuracy. With this exception, the data from this second section of the thesis add further evidence for the similarity of Persian literacy acquisition with that found in studies of English learners.

The final data collection section of the thesis focused on dyslexia, initially in Persian grade 1 and 2 children, and subsequently a comparison with an English speaking group of dyslexics. Consistent with evidence reported in the English language literature, the Persian dyslexic children showed evidence of poor literacy, phonological and verbal memory skills in comparison to their non-dyslexic peers. These differences were particularly evident in single-word reading and spelling and text reading speed. However, improvements were evident when connected text was used in the literacy task and accuracy was the measure of performance, suggesting that the dyslexic children were making progress in their literacy acquisition. The continued weaknesses found in the measure of reading speed was consistent with the deficits found in rapid naming. Phonological processing remained a problem for the dyslexics across both grades 1 and 2, although there was evidence of improvement in skills across these grades. Memory for visually presented familiar objects or contextually constrained sentences did not show the same differences between dyslexics and non-dyslexics evident when verbally presented words were
used, and visually presented letters showed differential improvements in memory for dyslexic children over the grades assessed.

When dyslexic Persian and dyslexic English children were compared with their non-dyslexic peers in the final study, the data also confirmed the similarity in patterns of weaknesses and strengths across the two language groups. Both grade 2 Persian dyslexics and year 3 English dyslexics showed deficits in literacy. However, when text reading was used rather than isolated word reading, the Persian dyslexics showed deficits mainly on reading speed, whereas the English dyslexics showed weaknesses on both accuracy and rate. Similarly, both Persian and English dyslexics showed evidence of weaknesses across different measures of phonological processing. There was evidence of weaknesses in the phonological awareness tasks, the rapid naming of verbal labels and verbal short-term memory.

10.2 Implications for research
The findings from this research provide evidence that models of English literacy ability and difficulties may be appropriately applied to, and used in explanations of variability of, Persian literacy. Those theories outlined in the introduction, therefore, may be applicable to developmental processes occurring within a Persian language cohort. These models, in the main, implicate phonological processes as a major source of influence on literacy acquisition, and the findings reported in this thesis seem to support this viewpoint. Those processes that lead to a recognition of units of sounds within words and the ability to manipulate those sounds, which may provide a valuable resource in the decoding of an alphabet, have the potential to
differentiate those Persian speaking children with average reading and writing skills from those with literacy levels indicative of dyslexia consistent to data found with English language dyslexia tests. However, there were differences between the Persian and English data reported. The main area of disparity between the data produced by children learning Persian and that of children learning English was when text reading accuracy was assessed. At least in its fully marked form, Persian is a relatively regular orthography, which is typically seen as supporting the acquisition of word decoding skills (see also Gholamain & Geva, 1999). This fully marker, more regular form is used specifically for early literacy learning and, as such, may be expected to lead to higher levels of early learning, particularly in word decoding (see also Siegel & Geva, 2000), than with the English orthography, which is less transparent. When decoding skills are well advanced, literacy weaknesses are less apparent in accuracy measures and seem more likely to show themselves in the ability to rapidly access a word label from a visual symbol – primarily in literacy, but also potentially in rapid naming tasks. The process of decoding may be accurate, but the process of making the accessing of whole word units fluent and efficient (or automatic) may be weaker amongst those with literacy deficits than amongst those with good reading accuracy scores. For English, a relatively non-transparent orthography, the evidence reported in this thesis is consistent with previous work arguing that phonological decoding continues to be a good predictor of variability in the accuracy of reading known words beyond the initial phase of learning to read (see discussions in Gillon, 2004; Snowling, 2000). However, for Persian, measures of fluency may also be required to fully assess the literacy skills of the early learner. For example, the Persian dyslexics studied as part of this thesis showed deficits in reading connected text, with those deficits being more evident in their rate of reading rather than in measures of reading accuracy, consistent with the argument that accuracy can reach high levels,
while rate is still poor. This dissociation between accuracy and speed has also been identified in other more regular texts (e.g., Wimmer, 1993; see also discussions in Goswami et al, 2000). The potential importance of fluency as an identifier also is consistent with the data reported in the present thesis for the Persian dyslexic children to show poor rapid naming speeds and for rapid naming being a predictor of word reading accuracy. Overall, these findings indicate that the type of script learnt does affect the manifestation of literacy learning problems, although at present they cannot be used to conclude whether these manifestations are due to different underlying causes – i.e., they cannot be used to distinguish between script dependent and universal cause hypotheses (see Geva & Siegel, 2000).

The findings supporting the ability of phonological processing to predict literacy levels even in relatively experienced Persian readers do corroborate the view that phonological processing skills are an important factor in the acquisition of literacy across different orthographies (see Goswami, 2004) and, therefore, supports the argument for phonological deficits being a universal cause of dyslexia (see Zeigler & Goswami, 2006). The present research identified these same phonological areas as deficient amongst Persian speaking dyslexics. Such profiles have been used as evidence for the view that dyslexics have difficulties that focus around phonological processing deficits (Snowling, 2000; Stanovitch, 1988). Similar conclusions have been derived from studies of English/Persian bilinguals (Gholamain & Geva, 1999) and of good and poor Arabic readers (Abu-Rabia, Share & Mansour, 2003). The current evidence for a correspondence between weak literacy skills and poor phonological ability adds further evidence for the generality of the phonological processing deficit. However, these findings cannot be considered totally conclusive for this position. The main problems that the current data present
for the universal position are the relationships identified between phonological measures and with literacy skills. The level of explanation of variability in literacy levels provided by the phonological measures suggests that other processes, not considered in this work, contribute to literacy acquisition amongst the Persian children - clearly, these need to be specified before universal claims can be fully support (see further research section below). However, the inter-correlations between different measures of phonological processing again cast doubt on the view that these are measuring the same underlying ability. This point has already been covered in the introduction to this thesis; however, the current Persian language data again confirm that measures of phonological awareness, phonological memory and phonological access are relatively independent skills within literacy learners. Consistent with previous research with English language cohorts (Wagner & Torgessen, 1987), the data from these Persian language children suggests that these different measures of phonological processing predict different variance in literacy, and may be exert more influence on different aspects of literacy (i.e., isolated word versus connect text processing). Placing these different measures within the same theoretical framework seems problematic given such evidence and universal theories of dyslexia and literacy acquisition that propose phonological processing as the main unifying skill need to explain these variations across languages and across measures.

Persian has the interesting feature (along with the Arabic from which the Persian orthography is derived) of using a more transparent form for early literacy learning, but a much more opaque form for general, more skilled use. Hence, if the relationship between literacy and phonological processing varies with transparency, then it might be expected to vary with experience of marked or unmarked text with age in the Persian cohort. Although this was not a primary area of investigation in the present work, there is evidence of variability of predictors across analyses
incorporating different grade groups and previous research has argued for such variability with literacy experience. For some, phonological decoding of words is a process confined to beginning readers. For adult, skilled readers, word processing is achieved via the orthographic features of the text, independent of the transparency of the script. This argument has been presented in terms of Farsi by Baluch and colleagues (Baluch, 1993; Baluch & Besner, 1991; Baluch & Danaye-Tousi, 2006; Baluch & Shahidi, 1991), based on data which indicated that the transparency of a Farsi word did not influence the time taken to respond to that word in a lexical decision task. However, the present data argue that phonological processing skills are important for older children – the grade 3 to 5 analyses suggested that the Spoonerism task was a significant predictor of literacy levels within this older cohort – and further research is necessary to contrast these positions.

10.3 Recommendations for practice

10.3.1 Assessment tools

The primary reason for this research was to inform the development of dyslexia assessment procedures. The current measures used as part of this research should help this process (see appendix 1). However, the findings should support further work in this area. In particular, the general findings of the research reported in this thesis argue that dyslexia assessments derived from work with English language children and adults can provide a basis on which to develop Persian measures. This seems particularly the case for measures of phonological processing – the main focus of the present work. However, two caveats need to be considered. First, the findings of the present Persian work concur with previous cross-language analyses that the features of the orthography influence the acquisition of literacy such that the rate of improvement in reading and
writing, as well as the level of literacy-related skills, may vary across different language cohorts.
In the present work, as well as the evidence that the ability of phonological awareness/decoding
processes to predict literacy levels is to some extent dependent on the transparency of the
orthography to be learnt, the data argue also for a relatively smaller influence of phonological
awareness/decoding measures on reading accuracy following the initial year of literacy learning,
which is characteristic of more transparent orthographies. In the case of Persian, this is most
likely due to the initial learning of the relatively shallow, fully marked text. Given this potential
influence, measures of processing speed or rate of reading may be better predictors of literacy
achievement than measures of phonological awareness or decoding accuracy amongst young
Persian readers/spellers. Clearly, reading accuracy shows variability in the Persian cohort –
which may be due to the need to switch to using a less shallow (unmarked text) – and the Persian
data were similar to the English in arguing for the importance of assessing reading accuracy;
however, further research seems necessary to confirm the importance of accuracy and to identify
whether measures of accuracy versus rate vary with experience of marked versus unmarked
forms, and whether measures of speed of processing or fluency might be a better predictor of
literacy acquisition than phonological awareness or reading accuracy scores. Therefore, the
current data argue for the use of accuracy measures to determine literacy levels and the
measurement of phonological processing skills such as an awareness of sounds within words that
support word decoding. However, the data also argue for these being supported by assessments
of fluency, both in terms of literacy rate measures and the assessment of underlying speeds of
phonological processing, such as in terms of rapid naming. For dyslexia assessment purposes,
whether these two areas of skill are due to the same underlying skills (as a universal position
would argue) or are due to separable areas of functioning (as alternative models would argue –
see, for example, Bowers & Wolf (2000) requires further research. The current data though suggests that a range of measures is necessary to distinguish appropriately the skills of the dyslexic Persian child from their non-dyslexic peers.

10.3.2 Ideas for teaching

In terms of its informing practice, the current research was aimed, primarily, at the speech and language practitioner in Iran, since these are the most likely individuals to be charged with the task of supporting the acquisition of basic speech sounds that impacts on literacy learning amongst children with a language-related problem. The role of the speech and language practitioner has been considered for some time. Rees (1974) argued that speech-language specialists should assess and develop linguistic prerequisites for reading, as well as assist students in developing specific linguistic awareness required for reading. Since this, a growing body of research supports the relationships between phonological awareness, reading acquisition and developmental reading disabilities, which were also identified in the current work. Spoken and written language are no longer viewed as entirely independent skills (Kavanagh, 1991). The speech and language specialist works directly with children who have developmental language impairment, and hence is ideally suited to identify and remediate the problems these students exhibit in phonological awareness, semantic and syntax skills, and meta-linguistic abilities. Training in phonetics, language acquisition, language disorders, and clinical experience quality the speech and language specialist as a member of the educational team treating language-based reading disabilities.
Broad research evidence indicates that phonological awareness may be the primary determinant of the reading problems that many young children experience (Fletcher et al., 1994; Liberman & Shankweiler, 1985; Stanovich & Siegel, 1994; Vellutino, Scanlon, & Spearing, 1995). This finding has led to a number of phonological and phonemic training studies. Results show that children's phonological awareness can be developed through explicit training in preschool or kindergarten (Ball & Blachman, 1988, 1991; Bradley & Bryant, 1985; Lundberg, Frost, & Petersen, 1988; O'Connor, Jenkins, & Slocum, 1995), even for children with very poor skills (O'Connor, Jenkins, Leicester, & Slocum, 1993; O'Connor, Notari-Syverson, & Vadasy, 1996).

In the majority of these phonological awareness training programs, three levels are included. The first aims at increasing word awareness through tasks that involve the dividing of sentences into individual words. The second level focuses on syllable awareness, and typically involves tasks that require the child to divide individual words into constituent syllables. The final level aims at increasing sound awareness (dividing syllables into sounds), with evidence suggesting that tasks that focus on phonemic segmentation (e.g., \( \text{CAT} = \text{C-A-T} \)) and blending (e.g., \( \text{C-A-T} = \text{CAT} \)) are the most crucial skills in this area.

Tasks that can be used to improve word and syllable awareness often involve listening activities, such as reading aloud to students, story telling, singing songs, word play, identifying missing words, etc. Listening activities may also play a role in tasks training the ability to manipulate sounds in syllables. Skjelford (1987) and Schneider (1997) reported that phonemic-or sound-segmentation “seem to be both the most important and the most difficult task in reading instruction”. Along with phonemic skills, students should be taught to assign letters to the sounds in a word and sound the word out (Ball & Blachman, 1988); ie, taught letter-sound decoding.
procedures (Rack, Hulme, Snowling, & Wightman, 1994). Other research suggests that sound categorization skills are crucial and can be developed easily in kindergarten; therefore, some researchers have targeted training on categorizing word sounds by initial sounds or rhyming parts, as in FAT/FIGHT or HAT/SAT (see Bradley & Bryant, 1985). Such skills may be related directly to reading by analogies, such as pronouncing LEAK by analogy with LEAN and PEAK (Goswami & Bryant, 1990; Goswami & Mead, 1992).

Such a practical program for training phoneme awareness could be used in every alphabetic language and should improve literacy levels in children with specific difficulties in this area of the curriculum (see ideas based on Goldsworthy, 1996, in appendix 2). However, despite the value of these phoneme-based programmes, the present data also argue for the importance of embedding this within practice with word reading and understanding. The development of word recognition skills that are not purely dependent on letter-sound decoding may be particularly important for the transition from the more regular marked form of Persian to the more opaque unmarked form. Programmes focusing on phonological skills early in learning have the advantage of allowing the identification of phonological-based deficits within first or second grades – particularly when a relatively regular orthography is used in literacy learning. This may be the explanation for the Iranian system to differ from the English system in the typical point of identification of dyslexia. In the Iranian education system, the current teaching methods and regular orthography allow the struggling child to be recognized quickly. In the English system, where a more mixed teaching system is used early in literacy learning, and a more opaque orthography is experienced from beginning reading, phonological problems will not be recognized early. If correct, these conclusions argue for the potential benefit of using a more
phonics based teaching system with a more regular orthography early in learning in both contexts (in English this may require careful selection of written material or the use of additional teaching aids to support decoding). However, after these initial periods of phonic-focused training, an increase in the use of visual/whole word recognition practice may be necessary to improve fluency in literacy. Both Persian and English literacy will require practice in both skills to allow the child to become a skilled reader and writer as early as possible. For the dyslexic, the process of early identification should also allow a process of early intervention to be implemented.

10.4 Future research

As an initial study into the potential application of English language derived dyslexia measures as a basis for the development of measures specifically for a Persian speaking population, the current work should be informative. However, there are weaknesses in this research and areas that require further investigation. The main weakness with the current work is that a number of measures showed ceiling effects earlier than expected within the cohort tested. This may be a specific feature of the Persian sample tested, given the method of teaching of a relatively transparent (as discussed above). However, it does suggest that further work is necessary to provide measures that can cover a larger age/grade level range than those developed for the current work. This restriction in variability due to ceiling effects will also have reduced the level of correlations between measures, which needs to be taken into account when making conclusions about relationships and predictors. Further work that uses harder test measures is needed to confirm the findings of the current work.
Even with the restriction in relationship between variables, the level of prediction of literacy found in the current work also argues for a wider range of measures to be used in future work. The aim of the present research was to focus on phonology as the main area argued to be related to literacy weaknesses and as a universal cause of dyslexia. The present data indicate that alternative measures may have to be considered to improve the level of prediction of Persian literacy levels. For example, measures of visual/orthographic or semantic/morphemic awareness may provide additional explanations of variability in literacy levels amongst Persian learners—such measures have been argued as possible additional areas of investigation in work in Arabic and Persian (see Arab-Moghaddam & Senechal, 2001; Elbeheri et al, 2006). The findings for the importance of fluency in the assessment of Persian literacy levels also argue for the further consideration of measures of speed of processing or automaticity (see Fawcett, 2002; Wolf & O’Brien, 2002) in the development of literacy and dyslexia assessment tools.

The current research focused on a cross-sectional design to investigate differences across grade groups. Additional evidence from longitudinal studies following the same group of children from grade 1 literacy learning to grade 5 would be worthwhile to support the conclusions derived from the current work. In particular, the effects of the change from predominantly marked to normally unmarked text that occurs from grade 1 onwards would be worthy of such longitudinal scrutiny. Whether the same measures predict variability across the two versions of the orthography and whether the same children show problems across these text types needs to be considered further. This would clearly be important for decisions about the type of assessment measures used across different grade groups. This work may build on the current data derived from studies of Hebrew and Arabic, both of which combine fully marked and unmarked written forms (see Abu-Rabia et
In addition, the evidence from the current work argues that visual memory and context can support the skills of Persian dyslexic children. This also requires further work to investigate whether these areas of ability can be used in the development of intervention methods. A child with literacy learning problems may need support to improve weak phonological skills; however, they can also be taught strategies to support acquisition, which may also increase self-esteem by including tasks that the child can achieve in as well as attempting to improve areas where the child is struggling (see Brooks & Weeks, 1999).

10.5 Conclusions

Overall, the findings of this work argue for the applicability of models derived from work on English speaking children for children learning to read and write in Persian. Therefore, assessment measures based on these English-language models should, following appropriate translation and modification, provide a basis on which to develop tools for identifying children with literacy weaknesses and dyslexia within a Persian language context. These data support the views that phonological processing is a key aspect of literacy development across different languages and argue for measures of such processes being a fundamental aspect of dyslexia assessment procedures in Persian. The findings are consistent with the hypothesis that children with dyslexia have a deficit in word processing skills that most likely originates in a phonological processing deficit, which leads to poor decoding. However, the main caveat to these conclusions relates to the use of fluency as well as accuracy measures in assessment
programmes. The findings of the present work with Persian learners argue for the use of measures that assess fluency of word decoding/recognition as much as accuracy. The arguments in this thesis suggest that the use of speed of processing measures in addition to accuracy measure will be particularly vital when assessing early readers learning a relatively transparent orthography. As such, although English-language-based assessment procedures will be informative, appropriate modifications need to ensure that fluency as well as accuracy is assessed. Additionally, although the data are consistent with the view that phonological processing provides a basis on which to assess dyslexia across languages, the more appropriate measures to use in assessment procedures across those languages may vary and research is needed to ensure that these measures are included in assessment procedures in a particular language context.
References


dyslexia, British Journal of Psychology, 74, 159-180.


Goulandris, N. (2003).Dyslexia in Different Languages, Cross linguistic comparisons. WHURR.


Schonell, F.J. (1950). Diagnostic and attainment testing. London: Oliver


Appendix 1
فرم ارزیابی اختلالات خواندن و نوشتن در دانش آموزان دبستانی (دانشگاه علوم توانبخشی کرمان)

tاریخ ارزیابی
نام آزمونگر
نام دانش آموز
تاریخ تولد روز ماه سال
پایه تحصیلی
زبان مادری
آدرس و تلفن منزل

<table>
<thead>
<tr>
<th>8 آزمون امتیاز</th>
<th>8 آزمون امتیاز</th>
</tr>
</thead>
</table>
| 1-شخص بینایی | 6-آزمون خواندن من
| 5-آزمون آگاهی واجی | درک مطلوب، صحبت خواندن و سرعت |
| ترکیب واجی، واج حذفی، تجزیه واجی، تبدیل | خوانندن |
| واجی | امتیاز کل |
آزمون تفخیض بینایی
الف) حروف پس از هر مشخصه کنید.
۱- شکل خوب تا زنگ کن. ش جای جای سهکتی مقابل آن بیان نکنید. گویی ۱- شکل دوباره با این پس از هر مشخصه کنید. ش جای آن بیان نکنید.
ب) قطب
ج) قطب
ف) بپ
د) بپ
۱- بپ
۲- بپ

۳- بپ
۴- بپ
۵- بپ
۶- بپ
۷- بپ
۸- بپ
۹- بپ

۱۰- بپ
۱- بپ
لا يوجد نص يمكن قراءته بشكل طبيعي من الصورة المقدمة.
(۵) تطابق شنوایی بینایی
به دقت گوش بده /ج/ آیا می‌توانی شکل این صدا را در بین این شکل‌ها نشان بدهی؟

۱ - /پ/
۲ - /ز/
۳ - /ح/
۴ - /ک/

کل سوال
۲ - آزمون تشخیص شنوایی

الف- بازنده‌ی صدا در کلمه به دقت به این صدا گوش بده /ج/ حالا سعی کن این صدا در بین کلماتی که من برایت می‌خوانم پیدا کنی. اگر این صدا را در کلمه شنیدی دسته را بالا بیاور.

خیابان بازی آخر فاصله کافی

کلمات با معنی
۱ - /ب/
۲ - /گ/
اینقر قاری باید خراب نتوپ
۳ - /د/
اگر نمک سگ نگاه پاک
۴ - /ژ/
انتو پامتو این دلیش نتو
ب- تبشیر یا جفت کلمات یکسان
در کلمه می شنوی که باید یک گویی این در کلمه یکسان است یا نه؟ بجای چجوگر اگر این دو کلمه را کمیت هم شیبدی یک گو به‌هنه آگر این دو کلمه مفل هم نبود یک گو نه. مثل بیل
bol کارداره
کاردلت
بوس یوس
خوت خود
نخ نخ
فلیل
قلم
سرد رود
دیک ریک
کیف گیف
موش موش

ج- تطابق شنوایی- کلامی
به دقت به کلمه ای که می شنوی توجه کن و دقیقا مثل آن را یک گو. /مغرور/ - - - -
مغرور

1- صبح
2- وقت
3- تاسیس
4- لنگ
5- هیجان
6- اشتیاق
7- مقررات
8- سرافرازی
9- بالاصله
10- خدمتکرای

2- آزمون سرعت نامیدن (تصاوير اشياء آشنا)
<table>
<thead>
<tr>
<th>۱-ر + آ (را)</th>
<th>۱-ر + آ (را)</th>
</tr>
</thead>
<tbody>
<tr>
<td>۲-ن + ز (از)</td>
<td>۲-ن + ز (از)</td>
</tr>
<tr>
<td>۳-م + ن (من)</td>
<td>۳-م + ن (من)</td>
</tr>
<tr>
<td>۴-س + گ (سگ)</td>
<td>۴-س + گ (سگ)</td>
</tr>
<tr>
<td>۵-ق + ر (قرص)</td>
<td>۵-ق + ر (قرص)</td>
</tr>
<tr>
<td>۶-ج</td>
<td>۶-ج</td>
</tr>
</tbody>
</table>

| ۱-بزرگ... حذف ب | ۱-بزرگ... حذف ب |
| ۲-صبر... حذف ر | ۲-صبر... حذف ر |
| ۳-ن فاجعه... حذف ش | ۳-ن فاجعه... حذف ش |
| ۴-شیر... حذف ش | ۴-شیر... حذف ش |
| ۵-سیم... حذف م | ۵-سیم... حذف م |
| ۶-اژه... حذف ا... | ۶-اژه... حذف ا... |
| ۷-پیشامد... حذف ش | ۷-پیشامد... حذف ش |

| ۱-آن... + | ۱-آن... + |
| ۲-پاز... + | ۲-پاز... + |
| ۳-است... + | ۳-است... + |
| ۴-شگرد... + | ۴-شگرد... + |
| ۵-شاید... + | ۵-شاید... + |
| ۶-ظاهر... + | ۶-ظاهر... + |
| ۷-ظرف... + | ۷-ظرف... + |
| ۸-مریض... + | ۸-مریض... + |
| ۹-میها... + | ۹-میها... + |
| ۱۰-طاقت... + | ۱۰-طاقت... + |

**شیعه اولین کلمه با شماره ۱ و شیعه دومین کلمه با شماره ۲ و غیره است.**
5- آزمون حافظه کلامی
(ماده) حافظه شنوایی کلامی (مدت)
بعد از شنیدن مداد این جمله، لیست کنید. تا جای دوباره سن کنید.

1- ۱۰۰۰۰، ج
 ۱- ۲۰۰۰۰، گ
 ۲- ۳۰۰۰۰، د
 ۳- ۴۰۰۰۰، پر، پر
 ۴- ۵۰۰۰۰، ق، ل، م، خ
 ۵- ۶۰۰۰۰، بی، ق، ل، و، ش

حالا یکبار تکرار کنیم، آن گران را تکرار می‌کنیم. اما این مدتی بعد از شنیدن
ساده‌تر از آن‌ها را بیان کنیم. مثل اگر عنوان جمله فر د پایه
یکمی فر جحالا یکبار تکرار گران کنیم، ن گ د س

(۱) حافظه شنوایی کلامی (کلیات)
كاملی که به شونی بالا می‌آید به شنیدن یکی بیان کنیم. لیوان شاپوری
جدب حالا یکبار تکرار می‌کنیم. ابتدا از چهار کلمه را تام در بی زمین، صیزه،

ناهی، خروش، سیب.

| ۱- مار، موت | ۲- نور، کتاب |
| ۳- لوب، میز | ۴- پرن، قاب |
| ۵- چو، شام | ۶- آب، روز |
| ۷- لیف، مار | ۸- بارون، زرد |
| ۹- تر، شم | ۱۰- قایم، زرد |

(۱) حافظه شنوایی کلامی (علاله)

۱- علی دوچرخه دارد.
۲- دوچرخه به توبی بانی می‌کند.
۳- نادر من باید سایه‌ی خیمه
۴- آموزش من با آموزش دو طبقه به مدرسه رفتم.
۵- امیر و اکرم دو سر برای خون‌های خانم‌ها نقش بچه
۶- سی و پی و مادرم برای تعطیلات عید با قطار به
۷- ۱۰۰۰۰، ج

خیاب طان بانی کرد.
<table>
<thead>
<tr>
<th>ع</th>
<th>ش</th>
</tr>
</thead>
<tbody>
<tr>
<td>گ</td>
<td>ض</td>
</tr>
<tr>
<td>ق</td>
<td>ن</td>
</tr>
<tr>
<td>س</td>
<td>ت</td>
</tr>
<tr>
<td>ف</td>
<td>ث</td>
</tr>
<tr>
<td>خ</td>
<td>ج</td>
</tr>
<tr>
<td>ذ</td>
<td>ح</td>
</tr>
<tr>
<td>ر</td>
<td>خ</td>
</tr>
<tr>
<td>غ</td>
<td>ق</td>
</tr>
<tr>
<td>ط</td>
<td>ق</td>
</tr>
<tr>
<td>فا</td>
<td>حروف پزیزی</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطmh</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطم</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطم</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطم</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطم</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطم</td>
</tr>
<tr>
<td>ناظر</td>
<td>فاطم</td>
</tr>
<tr>
<td>عدد</td>
<td>کلمات با اعراب (بابه اول و دوم)</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>من</td>
</tr>
<tr>
<td>2</td>
<td>سبب</td>
</tr>
<tr>
<td>3</td>
<td>مدرسه</td>
</tr>
<tr>
<td>4</td>
<td>کشاورزان</td>
</tr>
<tr>
<td>5</td>
<td>آفریده‌ای</td>
</tr>
<tr>
<td>6</td>
<td>قلم</td>
</tr>
<tr>
<td>7</td>
<td>وضو</td>
</tr>
<tr>
<td>8</td>
<td>علاقه</td>
</tr>
<tr>
<td>9</td>
<td>مطالعه</td>
</tr>
<tr>
<td>10</td>
<td>بلافاصله</td>
</tr>
<tr>
<td>11</td>
<td>لق</td>
</tr>
<tr>
<td>12</td>
<td>نعمت</td>
</tr>
<tr>
<td>13</td>
<td>سیله</td>
</tr>
<tr>
<td>14</td>
<td>مقام‌کش</td>
</tr>
<tr>
<td>15</td>
<td>نگذاشته‌ای</td>
</tr>
<tr>
<td>16</td>
<td>عضو</td>
</tr>
<tr>
<td>17</td>
<td>عرق</td>
</tr>
<tr>
<td>18</td>
<td>مایت</td>
</tr>
<tr>
<td>19</td>
<td>فعالیت</td>
</tr>
<tr>
<td>20</td>
<td>مرگ‌پی‌های</td>
</tr>
<tr>
<td>جمله</td>
<td>جمله</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>1-آبیر</td>
<td>2-مردم</td>
</tr>
<tr>
<td>6-نخ</td>
<td>7-معلوم</td>
</tr>
<tr>
<td>11-عقل</td>
<td>12-صحرا</td>
</tr>
<tr>
<td>16-عطر</td>
<td>17-عهد</td>
</tr>
</tbody>
</table>

درست کردن نام | نام کامل دانشجو | نام کامل دانشجو | نام کامل دانشجو | نام کامل دانشجو
آزمون خواندن ما (درک و حکمت)
پاستوول (۴۴ کلمه)
امین صبح زود از خواب بیدار می‌شود. او دست و صورت خود را با آب و صابون می‌شوید و دندانهاي خود را مسواک می‌کند. امین بعد از هربار غذا خوردن هم مسواک می‌کند و مسواک خود را می‌پز می‌شوید تا زود فاسد نشود.

۱) چرا امین مسواک خود را چیزی می‌کند؟
۲) امین در روز چند بار مسواک می‌خورد؟
۳) اگر صابون نباشد امین صورت خود را با چه چیزی می‌شوید؟
به چه مای روسیا چه فریب با با چه مای شهر دارند؟
۲ اکرم و امین در چه کارماهی به پدرشان کمک می‌کنند؟
۳ امین می‌گوید میوه چیدن از چه چیز مواضعیت می‌کند؟
۴ اصغر در چه کاری به کشاورزان کمک می‌کند؟
یک کودک خوب نباشد با آتش بازی کند و به وسایل خطرناک دست بزنند. چون آتش خیلی زود شعله ور می‌شود و می‌توانند قام خانه و خود کودک را بسوزانند. مطمئن‌باشید که کودک دست‌خورده زند. او دختر خوب و صبوری است. 
او از کمک کردن به مادرش لذت می‌برد. او می‌تواند سفره را بین و دعوته کند. با جاروبرقی اتاق را خیز کند و ظرف‌های شسته‌شده را با باید خشک کند. او با کارکردی خود را سرکرم می‌کند و همیشه وقت‌ام رنج‌شان را برد.

1. اگر آتش شعله ور بشود چه اتفاقی می‌افتد؟
2. مرج کردن سرکرم گردش چه کارهايی می‌کند؟
3. مرج چه کارهايی را می‌تواند در خانه براي کمک به مادرش انجام دهد؟
4. چرا مرج از تنهایی رنج می‌گیرد؟
5. مرج از چه کمکی لذت می‌برد؟
دانستان خروس و روباه از قصه‌های قدیمی و آموزنده
است. روباه مکار با حیله و نرگ‌های خود پسندیده‌ای خروس
استفاده می‌کند و او را فریب می‌دهد و خروس که
تعریف های روباه را درباره خوش صداپی خودش باور می
کند به راحتی فریب می‌خورد و با پسر چشم‌هاش منگام
آواز خواندن خود را به ملاکت می‌اندازد. این داستان
به همه خوانندگان پند می‌دهد که درباره خرفهای مردم
خوب بیانیشند و هر سخنی که می‌شنوند قبول نکنند.
هرکدام از داستان‌های کهن‌های حکمتی را می‌آموزد به‌جهه‌های
بايد سعی کند از قصه‌های کتاب درس‌های جدیدی فرا
بگیرند تا در زندگی موفق و پیروز باشند.

1) چرا روباه از خروس خواست که آواز خواند؟
2) چرا خروس تعیین می‌رود؟
3) چرا خروس به آواز خواندن کردن به انفعال افتاد؟
بجه‌ها باید هنگام عبور از خیابان به دقت به سمت راست و چپ خود نگاه کنند و هرگاه مطمئن شندند که رد شدن از خیابان بدون خطر است از آن عبور کنند. مرتئي همیشه مقررات عابر بیابده را رعایت می‌کنند. او به چراگ راهنمای توجه می‌کند و مرکز هنگام حرکت اتوبیل‌ها از چهار راه‌ها عبور می‌کند. یک روز عصر مرتئي شاهد یک تصادف بود. یک پسر بانزده ساله با یک موتور سوار که به سرعت از جاده گذشت در خورد کرد. او صدمه شدیدی دید و چند مرتبه دورتر در حالی که سر و صورتش شکسته بود بر روی زمین افتاد و بی‌هوش شد.

1) هنگام عبور از خیابان به کدام سمت باید نگاه کنیم؟
2) مرتئی قبل از عبور از چهارراه‌ها به چه‌چیز توجه می‌کند؟
3) چرا مرتئی هنگام عبور از خیابان تصادف می‌کند؟
4) پسری که در خیابان افتاده بود چه‌چیز تصادف کرده بود؟
5) چرا پسر بی‌هوش شد؟
6) چرا پسر چند مرتبه دورتر از جاده افتاده بود؟
زمایه که چشباپی از زمین سریع حرکت کند مکان است زمین
لرزه به وجود بیابد. هم روزه حاداقل یک هزار زمین
لرزه در کره زمین به وجود می‌آید.
پیشتر آنها خفیف محسود. اما سال‌های زمین زلزله‌های
شیده هم رخ می‌دهد و ساختن‌ها را خراب می‌کند. هر
زیمن لرزه یک کانون دارد که نقطه‌ی شروع زمین لرزه
است. چشباپی از زمین به طرف بالا و پایین و جنوب و راست
حرکت می‌کند و بودن‌های به وجود می‌آورد که در سراسر
پوسته زمین به شدت می‌شود. به این موجها امواج لرزان می
گویند. ریشه این لغت یونانی بوده و به معنای تکان
خوردن است. دانشمندان سراسر دنیا این امواج را روی
دستگاه زلزله نگار اندام‌های گیری می‌کنند.

۱) هر روز حاداقل چند زمین لرزه در کره زمین اتفاق می‌افتد؟
۲) چه زمین لرزه ای شدید می‌گویند؟
۳) نقطه شروع زمین لرزه را چه می‌گویند؟
۴) زمین لرزه چه معنایی دارد؟
۵) امواج لرزان به وسیله چه دستگاهی اندام‌های گیری می‌شود؟
۶) امواج لرزان در چه یک کیفی می‌شود؟
حروف زیر را دیکتکت بگویید.

س م ن ب د

کننده زیر را دیکتکت بگویید. (کلاس اول و دوم دبستان)

<table>
<thead>
<tr>
<th>شماره</th>
<th>کلمه</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-71</td>
<td>کیف</td>
</tr>
<tr>
<td>1-72</td>
<td>تفکر</td>
</tr>
<tr>
<td>1-73</td>
<td>شناخته</td>
</tr>
<tr>
<td>1-74</td>
<td>مشترک</td>
</tr>
<tr>
<td>1-75</td>
<td>مخفف</td>
</tr>
<tr>
<td>1-76</td>
<td>تاریخ</td>
</tr>
<tr>
<td>1-77</td>
<td>نظر</td>
</tr>
<tr>
<td>1-78</td>
<td>خطای</td>
</tr>
<tr>
<td>1-79</td>
<td>مراقبت</td>
</tr>
<tr>
<td>1-80</td>
<td>هوشیار</td>
</tr>
</tbody>
</table>

علی زیر را دیکتکت بگویید. (کلاس اول و دوم دبستان)

من اول:

کتاب مریم خرس و کثیف شده بود، او خیلی ناراحت بود. وقی زنگ
تفنیج زده شد ناظر یک کتاب علوم جدید به او داد. معلم دیروز
درس باغ آنار را خواند. طاهره میشود و در درس حاضر نبود.
مادرش پرای ای غذا نمی‌پخت.

من دوم:

در کارخانه حریر باقی قابل از آنکه کرم‌ها به پررانه تبدیل
پیواد آنها را کرم می‌کند. از بیله این کرم‌ها تارمای نطفه و
خشم ابریشم چنین می‌شود.
سلطانی مثل پرانونه برازی خیلی طرفین دارد و بسیار آن
روی عطر یا کلاهی می‌بودند و دریغ ندارد در مقابل بارادی بایدی
مقاومت کند.
آزمون تکمیلی (پایه های سوم تا پنجم)

1- آزمون سرعت نامیدن اعداد

رتبه

0 6 1 3 3 2 9 6

کد

6 5 4 3 2 1

کد

6 1 9 6 3 0

کد

6 3 0 9 1 6

کد

6 9 3 6 6 0
آزمون آگاهی واجی (تکمیلی)

الف-چندی واجی (کلمه ترکیبی پتو)
شرع
مشغول
نکات
روشناور
بوقلامون

ب-تیکچی واجی (کلمه ترکیبی پ+4+6)
سراب
مشکوک
انتظار
نیشنت
مقاومت

ج-آزمون تبدیل واجی (کلمه ترکیبی رئیس جهور)
صدای داغ
سیزده بدر
عهد نوروز
ماه رمضان
تاسوعا عاشورا
۳-آزمون سنگش حافظه فوري کلمات

مار، سوت
شر، دست، میز
آش، باد، پد
زرد، سوت، کور، باد، نور
پر، قاب، شیر، تاب، زود، مار

۴-خواندن کلمات با معنی

مقاسم
منسوخ
احترق
کومیجه
غرفاب
شجرب
شلف
اسکچ
سیجر
بلاثر
۵-خواندن کلمات آشنا با یه خصیلی سوم

عقل
ابر
صحراء
مردم
دبستان
هیشت
سازگار
اهیت
سپاسگزار
آفریننده
عطر
نخ
عهد
معلوم
تصادف
مسلم
خدمت‌گزار
بوکمون
خدا محافظ
روشنایی‌ها
atriq
mssql
miyar
mish
chot
nezeneh
mehad
mehadjidi
faz
en
ghrie
traz
mur
kstgah
obarneh
barneh
khn
yay
bi помом
farmanowian
tofaz
روی شاخه های خشکیده درختان، جوانه های سبز خوش رنگی روییده اند. شکوه های سنده و زیبا شاخه ها را تزیین کرده اند. پرنده ای را می بینیم که برگی خشک به منقار گرفته و به سوی بلندترین شاخه درخت پرها نیاز می کند. از پدرم می پرسم: بابا چگونه باید پیشین خاطره عید جیست؟

تعداد کلمات: 40
مدت زمان خواندن
غره صحت
تخوادن من نآشنم متاسب پايه خصیلی
سوم تا پنجم

امروز ما حاصل دانش و تجربه نسل هایی است که پیش از ما زیسته اند. ما نمی توانیم در این تخوادن شرکت جوییم مگر آنکه با اندیشه نسل هایی گنشته اشنا شویم. یگانه وسیله ای که ما را به این مقصود می رساند مطالعه کتابهایی سودمند عمی است.

این الله مدرس مرد دین و سیاست و مرد مبارزه و هجرت و جهاد بود. بسیار ساده زندگی می کرد. در احوال او نوشته اند: در اواکل جوانی که در مدرسه علمیه اصفهان دوران طلبگی و تحصیل خود را می گذراند، روزهای پنج شنبه و جمعه به کارگری می رفت و مزد این دو روز را صرف هزینه پنج روز تحصیل خود می کرد.

در تهران هم با اینکه وقتی مجلس بود می کوشید تا زندگی بر خرجی نداشته باشند راحتی به کسی بیده نکند. به ایران و استقلال و آزادی ایران خیانت علاقه داشت که از پوشیدن لباسهایی که از پارچه های خارجی تهیه شده بود خودداری می کرد.

تعداد کلمه: 145
زمان خواندن مت: ٧ دقیقه
فره صحت خواندان
فره درک مطلب
سوالات درک مطلب

1- برای آشنايي با افكار نسل هاي گذشته از چه وسيله
اي مي توان بهره بري؟

2- آيت الله مدرس در جوانی در چه شهری از شهرهاي ايران
درس طلبگي خوانده بود؟

3- آيت الله مدرس چرا از پوشيدن لباس هاي خارجي
خودداري مي كرد؟

4- برای گذاراندن خرج زندگي در دوران درس خواندن چه
كارهايی انجام مي داد؟
ادب معاشرت

در میان جمع گشاده رو بود و در تناوب سیمایی همرون و متفکر داشت هرگز به روی کسی خبره نگاه نمی کرد و بیشتر اوقات چشم هایش را به زمین می دوخت.

در سلام کردن به همه حیتی به کودکان پیش دستی می کرد. هرگاه به مجلسی وارد می شد، نزدیکترین جای خالی را اختیار می فورد. از بیماران عیادت می کرد؛ سخن هم نشین خود را غی برد، بیش از حد لزوم سخن غی گفت و اجازه نمی داد کسی جز در مقام دادخواهی در حضور از دیگری داده گویید و یا به کسی دشنام دهد.

همچنان هیچ گاه زبانش را به دشنام نمی آلود. بدرفتاری با شخص خود را می بخشید. ولی درباره کسانی که به حرم قانون تجاوز می کردند، گذشت و مدارا نداشت.

تعداد کلمات: 113
مدت زمان خواندن: 9 دقیقه

خود سخت
خود درک مطلب
1- حضرت عمّد (ص) هرکاه وارد علیس می‌شد چا کجایی نشست؟
2- مرگزم زبانش چه جز آلوده‌ی گی یوکرد؟
3- چگونه کسی که قانون را رعایت نمی‌کرد پایدار با او چگونه رفتار می‌کرد؟
4- رفتار او در سلام کردن چگونه بود؟
دیکته کلمات (سوم دبستان)


دیکته من نا اشنا

داستان خروس و روابه از قصه های قدیمی و آموزنده است. روابه مکار با حیله و نبرگ از خودپسنده خروس استفاده می کند و او را فرب می دهد.
دقاطع - توقع - قربه - صلحیت - ظریفی - مطمئن
خواهش - وحشانه ترین - معطر - ضروری - غلبه
اصلا - ذرین - منقار - مصدود - سکت - استقلال - آذوقه
دستانه ها - متاسف

دیکتاه متن ناورنا
در زندگی از حال دوئی می‌گفت به رؤی زمین می‌نشست و
زیراندازه قطعه حسیره بود و بالشی چرمی انباشته از
لیف خرما زیر سر می‌نهاد.
۲۷-دیکته کلمات (بنجم دبستان)

تقاطع-توقع-نظاره-موثر-عزم راسخ-تاجر-مذاب
مصائب-قریه-صلاحت-اضطراب-آذوقه-ظرفی-تصبیح
مطمن-خواش-مشنو-تامل-وحسانه ترین-دسته‌ها

دیکته متن نا اشنا

در زندگی از جمل دوری می‌جست به روی زمین می‌نشست و
زیراندازش قطعه حضیر پود و باشی چرمن انباشته از
لیف خرما زیر سر می‌نهاد.
Appendix 2
Goldsworthy
ایده‌هایی در فعالیت‌های آموزش واجی (مبتکر به ناتوانی‌های رشدی خواندن)
(1996): یک روند درمانی مبتکر به زبان
فعالیت‌های گوش کردن به منظورافراشم اگاهی از صدا
1- خواندن با صدای بلند: از کتاب‌هایی استفاده کنید که برصدای خاصی تاکید ورند. 
کتاب‌هایی حاوی تجاسی آوایی و assonance، 
مستند
2- داستان کوبی: مواردی را بکار برید که بر صداهای خاصی تاکید دارند.
3- بیماران شنیداری/ صدا دریک روز یا یک هفته
در حالیکه آزمودنی به انجام یک فعالیت تشویق می‌شود. برای مثال نقاشی کردن یک پازل داستانی را که دربرگیرنده نمونه‌های متعددی از یک صدای خاص است بخوانید. 
یا تصاویری را که با چاپ مشابهی آغاز می‌شوند نام ببرید.
یک صدا برای یک روز یا «یک صدا برای یک هفته» ممکن است به این صورت اجرا شد.
از آزمودنی خواسته می‌شود که تصاویر یا اشیاء که با صدای مشابه آغاز می‌شود، پیدا کند و آنها را در
کتاب الگا ترکیب کنند.
اشیایی که با صدای آغازین مشابه آغازی می‌شوند، در طراحی آتاق پیدا می‌شوند و یک چهار صدا یا
bad کنواخته شود.
گذشته شود.
Pickering (1994) بیان می‌کند که جهاب صدا چاپی که هرگز به محتوی اشیاء مختلفی است که
پاسخی آغازین مشابه شروع می‌شود
زماینده آزمودنی با اشیاء در جریان چاپی می‌شود، درمانگری اشیاء، را به‌هم می‌ریزد و آزمودنی می‌پایست.
اشیاء را براساس صدای آغازینشان دسته بندی کنید.
4- آواز خوانی انتخاب اهمیت‌هایی که برواجهای خاص تاکید دارند.
دستوری اجرایی اسلامی در هیچ‌جا

1- بازی صدا - صدای آواز

به آزمودنی بگویید که شما قصد انجام بازی را دارید که درآن برای تصاویری از اشیاء ارزان و بسیار جدیدی

ایجاد می‌کنید.

برای مثال برچسب گذاری اشیاء اتاق به اینصورت که همه آنها با صداهای جدا/شروع شوند.

Chair → bair
desk → besk

desk → besk

2- بازی صدا - صدای انتهایی

به آزمودنی بگویید که شما قصد انجام بازی را دارید که درآن با اضافه کردن یک صدا به انتهای

واژگانی که درواقع نام اشیاء در اتاق می‌سنند، بیان جدیدی بوجود می‌آورید.

desk → lampy

برای مثال

Humpty Dumpty

دوباره آن را بازنویسی موضوعی را با کار خوشه‌ای کنار بگذارد و از آزمودنی بهخواهید جای وابزه از دست

Humpty dumpty sat on a wall,

رفته را پرکند.

برای مثال

آزمودنی fall

Humpty Dumpty had a great ...

شکل گیری

4- تولید قافیه با بکارگیری واژگان معنی‌دار

(1992) به این نتیجه رسید که توانایی (مهمت) تولید قافیه طبق درخواست به اصطلاح

صرف‌دند. آن با‌این است واریانسی انسان است.

از آزمودنی بهخواهید واژاگ در بازی آزمودنی که با واژاگی که شما می‌گوید هم قافیه باشد.

برای مثال واژاگی بگو که با cat هم قافیه باشد.
5- تولید قافیه با اکثر گری از مانند
بیانی که درآمده از اکثر مانند
برای مثال واژه یک گو که با ٣٠ هم قافیه باشد.

6- بازشناسی قافیه

از بیمار بررسید که آیا ۲ واژه هم قافیه هستند؟ برای مثال آیا
هم قافیه است. HAT با CAT یا COAT با CAT آیا
هم قافیه است.

7- مقوله بندی صدا یا تشخیص عجیب قربن بودن قافیه

(۱۹۸۸) توضیح می‌دهد که مقوله بندی واقع در بازسازی قافیه مستلزم این است که از کودک
بی‌خواه و واژگان را با هم گروه‌بندی کند که دارای قافیه مشابه باشاند.

Bryan و Bradely (۱۹۸۲، ۱۹۸۵) از آن بعنوان تک‌لیف عجیب و غریب یاد می‌کنند.

8- تطابق قافیه

[ dog / cat / boat ] هم قافیه است؟ انتخاب کنید.

[ این طور نیست که یک تک‌لیف قضاوت در مورد قافیه نسبت به تک‌لیف تولید یا مقوله بندی که در بالا
به آن اشاره شد، حافظه بیشتری را به خود اختصاص دهد.

(۱۹۸۳) معاون رشنی قضاوت درباره قافیه زیرا پیشنهاد می‌کند که خودش به یک توالی آموزش
افزوده می‌شود.
(a) واجهای متدال به

(b) یک واج متدال در موقعیت‌های مختلف

(c) ۲ واج متدال در موقعیت‌های مختلف، تعداد کمتری از واجها سه‌پی هستند. در کودکان تضاد

پارزتری وجود دارد. بنابراین آن‌ها می‌توانند که حاوی ۱ واج متدال هستند یا بدون واج متدال هستند.

آسانتر قابل قضاوت هستند یا آن‌ها که دارای ۲ واج سه‌پی هستند.

Ball (1992) برای نگاهی اشاره کرد که اگر کودکان در هم قافیه‌های با مشکل مواجه‌اند استفاده از

حروفی که اصول متدال در واژگان را بازنمایی می‌کند منجر به تسهیل گروه‌بندی واژگان مصور

می‌شود.

۹- تطابق صدا

از آزمودنی بخواهید که تشخیص دهد کدامیک از ۴-۲ واج به یک صدای خاص آغاز می‌شود. CAT / Soap / Sup / Sink برای مثال: کدام واج به صدای S شروع می‌شود: 

تمرين با تصاویر انجام دهد و سپس فعالیت بدون تصویر را تکرار کنید.

۱۰- تولید واژگانی که با یک صدای خاص شروع می‌شوند.

از آزمودنی بخواهید: ۴-۲ واج به نام بیره که با صدای k شروع می‌شود. تقسیم می‌شود که با ۲ Onset-rime در واژگان تک سیلاپی که به Blending Sounds - ۱۱ خوشه همخوانی آغاز می‌گردد.

از آزمودنی بخواهید که اصول را با هم ترکیب کند و یک کلمه بسازد.

برای مثال بگویید /ot/ / sp/ / کریک کلمه بساز.

تقسیم می‌شود که با یک همخوان Onset-rime ۱۲- ترکیب اصول در واژگان تک هجا به ساده آغاز می‌شود.

از آزمودنی بخواهید صداها را با هم ترکیب کند و یک کلمه بسازد.

/ ih/ + /ot/ برای مثال /
Kit the Indian and the pit.
Kit dug a pit. Kit got wood for the pit.
The wood fit in the pit. Kit lit a fire.
Kit put meat over the pit to cook.
Kit, sit and wait.
Kit took the meat off with
A mit(t) kit bit the meat
Kit said it was good (p. 34)

/jelkowitz, 1980) say-c-a-t
/p/, /b/, /t/, /d/, /k/, /g/
پچه ما پایین اسات ء را با یکدیگر ترکیب کنند تا به نام حیوانی که آزمون نگر در ذهن دارد دست یابند.

15- دسترسی به صدای آغازین از آزمونی بخواهد به شما بگوید در آغاز یکی از واژگانی که شما می‌گویید کدام صدا حذف شده است.

برای مثال: *can*, *at* - حذف شده است
کدام صدا را شما در *can* می‌شنوید یکی در کدام کلمه* at* در صدای انتهایی

16- صدای انتهایی supplying از آزمونی بخواهد که به شما بگوید کدام صدا در یک پایان یکی از واژگانی که شما می‌گویید حذف شده است.
شده است براي مثال شما چه صدایی را در انتهایی *Can* می‌شنوید یکی در کدام کلمه* Ca* - حذف شده است.

17- قضاوت درباره تشخیص همخوان آغازین از آزمونی بخواهد که تشخیص دهد کدام یکی از ۲ واژه زیر با صدای مشابه آنچه در آغاز واژه هدف شنیده می‌شود آغاز می‌شود.
برای مثال: کدام واژه با صدای مشابه نخستین صدای آغاز می‌شود cat

18- قضاوت در تشخیص همخوان انتهایی از آزمونی بخواهد که با واژه زیر با صدای مشابه آنچه در پایان واژه هدف شنیده می‌شود پایان می‌پذیرد.
برای مثال: کدام واژه با صدای مشابه آنچه در پایان cat می‌شود پایان cat می‌پذیرد.

19- تشخیص صدای (مستمر) آغازین از آزمونی بپرسید صدایی را در آغاز ۱ تا ۳ واژه هدف می‌شنوید تشخیص دهد.
برای مثال نخستین صدایی که در *mine/ moo/ me/ mum* می‌شنوید کدام است.

20- تشخیص صدای انفعالی آغازین (و واژگانی با انتخاب کنید که با همخوانی این پیوسته آغاز می‌شوند)
از ازمودنی بخواهد صداپی را که در آغاز ۴-۱ وازه هدف می‌شوند تشخیص دهد.

برای مثال: نخستین صداپی را که دراین واژگان می‌شنود کدام است که با اصوات انفجاری آغاز می‌شوند مانند $g$, $k$, $d$, $t$, $b$, $p$, $f$ و انتخاب کنید.

**۲۱ - تشخیص تفاوت هم‌خوان آغازین**

که به آن بعنوان یک تکلیف عجیب و غریب و اشکالی نتایج می‌شود.

از ازمودنی بخواهد که کدام واژه از ۲ یا ۴ واژه زیر با صداپی متافوتوت آغاز می‌شود.

banana/ ball/ horse/ bat؟

برای مثال: کدام واژه صداپی پایانی متافوتوت دارد؟

از این تکلیف بعنوان یک تکلیف مقوول بنده صنا (( odd one out)) یاد Bryant و Bradley می‌کند.

**۲۲ - تشخیص تفاوت هم‌خوان انتهاپی**

از ازمودنی بخواهد تشخیص دهد کدامیک از ۲ یا ۴ واژه زیر با صداپی متافوتوت پایان می‌پذیرد.

sit/ dog/ coat/ cat

برای مثال: کدام واژه صداپی پایانی متافوتوت دارد?

**۲۳ - یافتن کردن صداپی آغازین**

از ازمودنی بخواهد صداپی که کلمه را تغییر دهد.

brای مثال: بگو CAT، آکنون به جای $K$ اول $S$ بگذار و کلمه را بگو.

**۲۴ - یافتن کردن صداپی انتهاپی**

از ازمودنی بخواهد صداپی انتهاپی در که واژه را تغییر دهد.

brای مثال: بگو CAT آکنون به جای $t$ آخر $n$ بگذار و کلمه را بگو.

**۲۵ - Matching**

صدای آغازین در کلمه با کمک بردن کلمات معنی‌دار واقعی

از ازمودنی بی‌پرسید آیا فلان واژه با صداپی خاصی آغاز می‌شود یا دکتری جواب صحیح یا غلط پیشنهاد کنید.

برای مثال: آیا CAT با شروع می‌شود / آیا CAT با $K$ شروع می‌شود / آیا CAT با $T$ شروع می‌شود.
صدای آغازین در کلمه با بکارگیری واژگان مبتنی و غیرواقعی

از آزمودنی بپرسید آیا این واژه با صدای خاصی آغاز می‌شود.

پاسخ صحیح یا غلط را پیشنهاد کنید.

برای مثال: آیا با $m$ با gat/ با $	ext{g}$/ شروع می‌شود یا با آیا با cat با t با $k$ پایان می‌پذیرد.

صدای انتهایی با بکارگیری واژگان مبتنی یا غیرواقعی

از آزمودنی بخواهید به شما یک راه آید آیا آن واژه با صدای خاصی پایان می‌پذیرد.

پاسخ صحیح یا غلط را پیشنهاد کنید.

برای مثال: آیا با t/ با $k$ پایان می‌پذیرد یا با $t/ با cat

صدای انتهایی در واژگان مبتنی یا غیرواقعی

از آزمودنی بخواهید صدای آغازین نیست یا $	ext{cv}$. (c:V:V) به یک صدای مجزاست

برای مثال: صدای آغازین در 

30- 6 تحقیق(تفکیک) صدای آغازین در واژگان مبتنی و غیرواقعی

از آزمودنی بخواهید صدای اول واژه را تشخیص دهد.

برای مثال: صدای آغازین در 

31- تحقیق(تفکیک) صدای انتهایی در واژگان مبتنی دار حقيقة

از آزمودنی بخواهید صدای انتهایی واژه را تشخیص دهد.
برای مثال، صدای انتهایی

۲۲ - تقطیع(تفکیک) صدای انتهایی در واژگان به معنی یا غیرواقعی
از آزمودنی بخواهیت صدای انتهایی در فلزن واژه را تشخیص دهد.
برای مثال: صدای انتهایی در gat چیست.

۲۳ - تقطیع صدای میانی در واژگان معنی دارد و واقعی
از آزمودنی بخواهیت صدای میانی دریک واژه را تشخیص دهد.
برای مثال: صدای میانی در cat چیست.

۲۴ - تقطیع صدای میانی در واژگان غیرواقعی و بی معنی
از آزمودنی بخواهیت صدای میانی یک واژه را تشخیص دهد.
برای مثال: صدای میانی در gat چیست.

۲۵ - محاسبه و تفکیک تمامی اصوات در واژگان معنی دار و واقعی
از آزمودنی بخواهیت تمامی صدایها یک کلمه را تشخیص دهد.
با کلمات تک سیلابی ۳ صدا آغاز کنید.

برای مثال، چند صدا در واژه CAT می‌شوند؟

۲۵ - محاسبه و تفکیک تمامی اصوات در واژگان غیرواقعی یا بی معنی
از آزمودنی بخواهیت تمامی صدایها دریک واژه را تشخیص دهد.
کار را با واژگان تک سیلابی ۲ صدای یک آغاز کنید.
برای مثال، صدای یک واژه CAT در واژه اینفیتی می‌شوند؟

۲۷ - حذف صدای آغازین
از آزمودنی بخواهید صدای آغازین یک کلمه را حذف کنید.
برای مثال: به گو آماده گو اما گو.
28- حذف صدا پایانی
از آزمودنی بخوایید صدا پایانی فلان و آن را صرف کنید
برای مثال: بگو: ان را دوباره بگو اما /l/ نگو

29- حذف صداها در وازگان
از آزمودنی بخوایید یک صدا را در وازه حذف کنید
برای مثال: بگو: slip آن را دوباره بگو اما /l/ نگو

30- جانشین کردن صداها در وازگان
از آزمودنی بخوایید یک صدا را در وازه جانشین کند
برای مثال: بگو: slip آن را دوباره بگو اما به جای l بگو k

(Secret language)

41- پادگنیزی

برای مثال

از آزمودنی بخوایید که همخوان ابتدایی یک واژه را در انتهای قرار دهد و یک صداهای کشیده (طولانی)

اضافه کنید /a/

amplay می‌شود

Elkonin boxes

42- ارتباط اجزاء صدا و حروف از طریق

Say- it- and- move it and printing

Elkonin مراحل فعالیت‌های تفکیک واحد خلاصه کرده است.
Blachman (a

1- تصویر یک شخص یا شی به آزمودنی داده می‌شود که نام آن در خزانته وازگانی آزمودنی است. 
این کار با خشونتی هایی /fr/, /s/, /v/ هایی مثل fricative آموزش اولیه باید شامل وازگانی شود که با آن آغاز می‌شود. 

2- جعبه‌هایی در زیر عکس ترسیم می‌شود و تعداد جعبه‌ها با تعداد واجه‌ها تشکیل دهنده وازه

مصور همخوانی دارد برای مثال ۳ جعبه زیر تصویر man ship یا ya man 

3- زتون های رنگی (همه به یک رنگ) به آزمودنی داده می‌شود.
آزمودنی نام تصویر را به آمسترگی می گوید و یک زتون درهمیک از جعبه‌های مربوطه در زیر تصویر قرار می‌دهد.

بعد از اینکه آزمودنی این فعالیت را یادگرفت، زتون هایی با رنگ‌های متغیر به آزمودنی داده می‌شود تا در جعبه‌های زیر تصویر قرار دهد

اکنون همکارها با یک رنگ و واکه‌ها با یک رنگ دیگر مشخص می‌شوند. کند، manipulate آزمودنی توانست زتونها را برای نمایش همکارها و واکه‌ها حروف روزی زتونها نوشته می‌شود و آزمودنی به فعالیت ادامه می‌دهد. سرانجام، tile حروف چایگزین

زتونها می‌شوند.

2- بعد از اینکه آزمودنی می‌خواند (Blachman و Ball say- it, And- move- it در روش آنها) آزمودنی می‌خواند (b) آزمودنی می‌خواند (Blachman و Ball say- it, And- move- it در روش آنها)

نشان دهنده که در بالای عکس روزی کارت ثبت شده‌اند. آیتم صدا را پابرجای می‌گذارند. به آزمودنی آموزش داده می‌شود که هر روزی که در حالیکه یا هر روزی یک خط زیر

آزمودنی تصویری پایین می‌آورد اتصال ترکیب شده تکرار می‌شود و آزمودنی می‌باشد.

print پلاستیکی استفاده می‌شود.

43- جانشینی صدای مایانی (تنها زمانی که حروف یا از آزمودنی می‌خوانند صدای مایانی یک وازه را تغییر دهد تا از وازه جدید بسازد.

برای مثال: را به pet تغییر بده.