UNIVERSITY OF READING

Reading and reading-related skills in Arabic-English bilingual speakers in the UK and Saudi Arabia for typical children and children with reading difficulties

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Abstract

This thesis examines reading and reading-related skills in typically developing children and children with specific reading difficulties in Grades 3-6 who are learning to read in Arabic and English, as well as monolingual Arabic-speaking children. The children were tested on measures of phonological awareness (PA), rapid automatised naming (RAN) and phonological memory (PM), as well as reading efficiency and reading accuracy.

Study 1 investigated Arabic-English biliterate children who attended schools either in the UK or Saudi Arabia. They performed better in English than Arabic on reading efficiency, PA, and RAN tests. Those in the UK showed higher scores than those in Saudi Arabia in English and, surprisingly, in Arabic. However, there was no significant difference between the participants' reading accuracy and PM scores for English and Arabic.

Then, a comparison was performed with Arabic monolingual speaking children who attended private schools. There was a significant difference between the level of Arabic reading efficiency of the biliterate children and monolingual readers. No differences in reading accuracy performance were found between the biliterates and monolinguals. In addition, the monolinguals slightly outperformed the biliterates in the PA and PM tasks, and they completed the RAN (digits and letters) tasks much more quickly. Furthermore, PA and RAN digits, but not PM, were significant predictors of reading word efficiency in Arabic. However, only PA predicted reading accuracy in Arabic.

The participants in Study 2 were 28 Arabic-English bilingual children with reading difficulties. Their PA, PM, RAN, reading accuracy and reading efficiency were found to be worse than those of the typically developing children in Study 1, indicating they had impairments in phonological processing.

The large differences found between the languages and the country of residence suggest that exposure to language, reading instruction and education system may differentially affect learning to read in English and Arabic.

Declaration of Original Authorship

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Suhair Alhelfawi

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Chapter 1 Introduction

1.1 Research Background

Reading is an essential part of academic learning and a crucial stepping stone to becoming an informed community member and enhancing well-being (Harrison, 2003). Zeffiro and Eden (2000) argued that reading is a prerequisite for success in life and that reading failure prevents individuals from building further foundational skills. Therefore, it is important to understand the causal mechanisms that underlie successful reading to identify children who struggle to read and then design evidence-based interventions to help them.

The simple view of reading (SVR; Gough & Tunmer, 1986) identifies two components necessary to achieve successful reading comprehension of a text: word reading (decoding) and language comprehension. In the early phases of learning to read, word recognition and reading comprehension are difficult to separate. Hoover and Gough (1990) stated that language comprehension without decoding is not possible. When children become more fluent readers, reading comprehension becomes closely connected to but distinct from the ability to recognise simple words (Catts et al., 2003). Decoding skills demand awareness and experience of print materials alongside (for most children) explicit reading instruction. The important role of word reading is enshrined in the SVR framework. Therefore, it is critical that children learn to decode accurately and fluently, as this is the gateway to developing broader reading comprehension skills.

Research has established the importance of phonological skills in learning to read (Bradley & Bryant, 1978; Goswami & Bryant, 2016; Snowling et al., 2000). A close, reciprocal relationship has been found between children's phonological (speech sound) skills and the development of word reading skills (National Institute for Literacy, 2008; Wagner & Torgesen, 1987). Phonological awareness, the ability to recognise and manipulate sound segments in words, is one of the most important abilities in early reading development (Share, 1995). It is a core skill that requires learners to notice, think about and work with individual sounds. They must comprehend that words are made up of combinations of diverse sounds, or phonemes, as a foundation for learning to decode, or sound out, specific words.

Word recognition is complex and comprises at least two different types of processes: alphabetic decoding, or sounding out, and direct access to orthographic (written language system) representations of known words. The ability to use the alphabetical code that interconnects phonemes and graphemes underlies overall reading process. Children must understand the alphabetic principle, and they must know the letter–sound correspondences

before they can be taught to accurately and automatically decode words, in a process that has been described as phonological recoding (Share, 1985), or more colloquially, 'sounding out'. Through frequent exposure to written material, orthographic representations of letter combinations and entire word units are encoded in the mental lexicon. To recognise a word accurately, it is necessary to know how the letters are combined to produce that word. As such, recognition develops over time, access to orthographic representations becomes more automatic and reading becomes more fluent (Ehri, 2005, 2014). Orthographic skills are therefore important, alongside phonological skills, for efficient word reading.

Phonological processes are crucial for forming orthographic representations. Children first sound out words, letter by letter, and then begin to process large orthographic units, as described by Share (1985). An important theory of reading development was proposed by Frith (1985), who argued that reading development consists of three stages in which the child adopts a different reading strategy at each stage: logographic, alphabetic and orthographic. According to Ehri (1998) and Share (1995), phonological recoding is the primary mechanism of word knowledge acquisition. The bootstrapping mechanism involves the connection between the child's pre-existing linguistic knowledge and the features of the target language. This indicates that learning to read places a huge emphasis on phonological processing from an early age (Höhle, 2009). Phonological skills are a fundamental prerequisite for storing and accessing orthographic representations. The aim of this thesis was to look in more detail at phonological processing to shed light on which specific aspects (phonological awareness, phonological memory and/or rapid automatised naming) are particularly important.

The phonological depth of alphabetic writing systems can range from shallow to opaque, and the regularity or irregularity of their orthographies can be categorised according to this dimension. Readers must be aware that certain printed letters contain more than one sound representation in alphabetic languages. For instance, the letter 's' is pronounced as s in 'son' and as z in 'was' (Seymour et al., 2003). Alphabetic languages can have transparent or opaque orthographies, which indicate the depth of orthography. Some languages, such as Spanish, Italian and Greek, have more transparent orthographies. In transparent orthographies, each grapheme corresponds to one phoneme, and this is consistent (Ziegler et al., 2010). Because there is a consistent relationship between graphemes and phonemes, when learning to read, children quickly become accurate readers and therefore reading difficulties are usually observed in reading fluency rather than accuracy (Cuetos & Suárez-Coalla, 2009; De Jong & Van der Leij, 2003; Spinelli et al., 2005; Zoccolotti et al., 2005). Ziegler and Goswami (2005) formulated the psychological grain size theory as a basis for studying the

effect of cross-linguistic differences in orthographic transparency on reading development. According to this theory, reading accuracy and speed differ across orthographies because of fundamental differences in phonological recoding and reading strategies. The focus of this thesis is on the decoding/word recognition element. Opaque orthographies are discussed later.

As the present research focuses on Arabic–English bilingual learners, it is important to explain the Arabic language structure. Arabic has a complex orthography. Because it is an abjad (for more details, see Section 2.3.2), vowels are not represented by graphemes (with the exception of three long vowels). Instead, when (short) vowels are represented in a text, this is done with a diacritical mark above or below the corresponding letter, and this is typically done only in children's texts and religious books. This means that with diacritics, Arabic has a highly transparent orthography. However, Arabic can also be an orthographically opaque language when the text is written without diacritical marks, as is the case in books for older children and adults. This means that when children learn to read, they have to make a jump from a more transparent to a less transparent orthography.

In addition to the presence or absence of diacritics, children learning to read Arabic face many other challenges. For example, a cursive script is used where most of the letters are joined (e.g. laeib/لعب), and each letter has a different shape depending on the position it takes in words; for example, the letter 'ea' (ع) has more than one shape (عـ/ـعـ/ـع) based on whether it appears at the beginning, middle or end of a word. Written Arabic orthographic features can generate a visual load, affecting reading speed and slowing the orthographic process (Eviatar & Ibrahim, 2000). Reviewing existing research by Azzam (1984), Eviatar et al. (2004) and Eviatar et al. (2019), it is found that even among skilled readers whose first language is Arabic, reading acquisition and reading of single words are slower than for other languages such as Hebrew. Arabic's visual complexity may slow down automaticity in reading. A study was conducted by Abdelhadi et al. (2011) to establish the visual complexity of Arabic, which has an impact on the reading process. They employed a simple detection test, and the participating children had to identify a vowel diacritic in the context of Arabic and Hebrew words and nonwords, as well as nonletter stimuli that look like Arabic or Hebrew letters. The sample comprised 82 children in Grade 3 and Grade 6 who spoke Arabic as their first language and Hebrew as their second. It was reported that these children found processing scripts in Arabic more challenging than Hebrew scripts. This observation is attributable to the greater visual complexity in the Arabic orthography.

Arabic is also a diglossia, having both a colloquial spoken form and a standard form. Phonological, lexical and syntactic differences exist between the spoken and written forms. From birth to school age, children are exposed to the spoken form at home, and when starting school, they begin using the standard form (Eviatar & Ibrahim, 2000; Saiegh-Haddad, 2003, 2004, 2005). This means that to some degree, they have to learn a new language as they learn to read for the first time. The words they learn at home are from local Spoken Arabic, and in school, they begin to learn Standard Arabic, which is used and understood more widely. In English, the differences between spoken and written forms are far smaller.

Educators and authors are concerned about the discrepancy between colloquial forms of Arabic, which are the native mother tongues of the speakers, and Standard Arabic (Abdulaziz, 1986; Bani-Khaled, 2014; Saiegh-Haddad & Everatt, 2017). Unlike Spoken Arabic, which varies from one Arab country or community to the next, Standard Arabic is mostly utilised in written texts, tests, assignments and formal situations, and it is rather uniform throughout the Arab world. Because of this, students have the challenge of receiving instruction in one format (Spoken Arabic, specific to where they live) while reading and writing in another (Standard Arabic, more universal). Saiegh-Haddad and Haj (2018), for example, found that the phonological distance between the two forms of Arabic may differ in the extent of distance, proximity or overlap with each other. They can range from being almost identical to being entirely different. The distances between Spoken Arabic and Standard Arabic have a substantial impact on the quality of phonological representations across all school grades. For example, the word rah/راح (went) is used in Spoken Arabic and is used often in spoken Hejazi dialect.

Hejazi is spoken in the western part of Saudi Arabia. It is the outcome of the unique immigration from all over the world to the two holy cities, and as such the Hijazi dialect is a fusion of many different languages and cultures. There are numerous words borrowed from Turkish Urdu. Additionally, the Egyptian language has had an impact on it. In Hijazi dialect, the alphabet continues to use the same set of letters as standard Arabic.

In Standard Arabic, the word rah/ is not used, especially in writing; the word zahaba/ ذهب is used. The use of Standard Arabic is encouraged when writing formally, since it is understood by speakers of all dialects, not just the Hejazi dialect. The words are very different, in both their written and spoken form, but they mean the same thing. In the schools where the research was conducted, a mixture of local and Standard Arabic was used. For instance, all the textbooks utilised Standard Arabic, although the teachers used Spoken

Arabic when addressing students during class. More detail about diglossia can be found in section 2.3.1.

Bilingual children learning to read in Arabic face many challenges in terms of dialect, including separating Standard and local Spoken Arabic. Learning to read in English is also challenging, as English is an outlier on the orthographic transparency continuum. Seymour and colleagues (2003) investigated the development of decoding skills in 13 alphabetic languages. In letter knowledge, familiar word reading, and simple nonword reading tasks, the children demonstrated poorer performance in reading familiar words and simple pseudowords in Portuguese, Danish and French than in other European orthographies. English was the most poorly performed language of all. English was also the language with the most opaque orthography. Differences in orthographic depths between languages therefore seem to reflect variability in the development of the ability to read both words and pseudowords (Seymour et al., 2003). Compared to vowelled Arabic (i.e. with diacritics), English is much more orthographically opaque, and this is a relative benefit for children learning to read Arabic in the early stages at least (more transparent orthography).

Strong phonological abilities help students successfully acquire reading skills. The three major phonological processing abilities described by Wagner and Torgesen (1987) are phonological awareness (PA), phonological memory (PM) and rapid automatised naming (RAN). These three abilities are crucial in supporting the development of reading skills. Wagner and Torgesen (1987) showed that these processing skills are related to each other. Numerous studies have questioned what underlies RAN's link to reading. Wagner and Torgesen (1987) argued that the phonological aspects of the RAN task alone accounted for RAN's link to reading. They revealed that RAN was associated with reading fluency, and both required effective access to and retrieval of phonological representations from long-term memory. Others (Bowers & Wolf, 1993; Powell et al., 2007) have argued that other cognitive processes involved in the RAN task are also important. Georgiou and Parrila (2020) and Norton and Wolf (2012) suggested that RAN and reading were associated because they rely on similar linguistic and non-linguistic cognitive processes.

While Wagner and Torgesen's (1987) claim that RAN is related to phonological processing is now debatable, this classification is used in the present analysis when illustrating phonological processing because it is still recognised by many scholars and researchers (Anthony et al., 2006; De Jong & Van der Leij, 1999; Nelson et al., 2012). RAN is discussed in greater depth in the literature review chapter. The foundation of reading skills

is phonological processing abilities. It is essential to understand this concept because knowledge of the relationships between phonological processing abilities and reading is essential for helping children who are at risk of reading difficulties.

Dyslexia is a specific learning difficulty that creates challenges for reading. Children with dyslexia may have a variety of deficits in their phonological processing abilities, which may lead to difficulties in learning to read (Ramus et al., 2003). Individuals with dyslexia, even if they receive proper guidance and sufficient encouragement, still have difficulty reading and spelling accurately and fluently (Lyon et al., 2003).

Dyslexia manifests differently in different languages due, in part at least, to differences in orthography. In some studies, the effect of phonological awareness on reading development was shown to be greater in less consistent orthographies (Mann & Wimmer, 2002; Ziegler et al., 2010), whereas other studies have found that phonological awareness is an equally strong predictor of reading development in English and more transparent orthographies (Caravolas et al., 2012). Cross-linguistic differences in the influence of PA on reading, in terms of the influence of phonological awareness on reading over time, have also been suggested. It has been argued that the predictive power of phonological awareness decreases in more consistent orthographies after about one year of reading instruction (Georgiou et al., 2008; Vaessen et al., 2010) because decoding skills have been adequately established by then.

Wydell and Butterworth (1999) presented a case study of a 16-year-old bilingual English-Japanese boy who showed reading difficulties in English but not in Japanese. The boy read both Kana and Kanji characters well, and they argued that this was due to the nature of the two orthographies. The boy did not show any difficulties in Kana, as it is highly consistent (at the syllable level), and he did not show any difficulties in Kanji because it is based on the 'granularity' level, so the smallest orthographic unit in Kanji, which represents sound, is at the level of the whole word. Wydell and Butterworth suggest that English grapheme–phoneme relationships are not straightforward and that children need time to learn them, as discussed in detail in the literature review (section 2.7.3). It is notable that they did not test him on reading nonwords in Japanese; if they had, he presumably would have had similar difficulties to those he had with English.

Studies of dyslexia in the Arab world are quite rare (Abu-Rabia & Abu-Rahmoun, 2012; Elbeheri & Everatt, 2007; Gharaibeh, 2021; Layes et al., 2015). Most Middle Eastern education ministries seem to follow and translate the American or British definition into Arabic (Elbeheri et al., 2006; Mahfoudhi et al., 2012), maybe because it has a longer history

or more research in that field. At present, school psychologists and special education teachers in the Kingdom of Saudi Arabia (KSA) lack Arabic standardised testing for assessing and diagnosing dyslexia (Aba-Hussein, 2021). As a result, few intervention approaches have been developed for use with dyslexic children learning Arabic to help them read and write (Elbeheri et al., 2009). The low number of dyslexia diagnoses in the KSA is related to the lack of assessment tools in the Arabic language, meaning that educators and parents lack awareness about dyslexia (Al-Shareef, 2017).

It may be that dyslexia has the same cause across all languages and language learners, but the way this common cause manifests in the development of reading and writing may vary. Reading and writing problems are a consequence of the underlying cause – and the level and type of consequence will vary depending on the features of the writing system. Alternatively, the underlying cause could vary across languages: dyslexia in a more transparent orthography may be caused by something that differs from the cause of dyslexia in a less transparent or non-alphabetic-based orthography. More detail about dyslexia in different languages can be found in Section 2.6. To further our understanding of dyslexia as it occurs in bilingual children, two hypotheses have been put forward. Cummins (1979) proposed the linguistic interdependence hypothesis, and later, Saiegh-Haddad and Geva (2007) supported the script-dependent hypothesis. The script-dependent hypothesis argues that the orthographic features of a specific language affect reading development in that language only (Shakkour, 2014). Therefore, the patterns of strengths and weaknesses that emerge as children learn to read a first language may not necessarily influence their reading of a second language with a different orthography.

Both hypotheses postulate how children develop reading skills in more than one language. According to the linguistic interdependence hypothesis (Cummins,1979), having strong abilities in one language helps to master a second language, and because of this, it is possible that strong L1 proficiency may be associated with L2 proficiency in underlying skills or specific linguistic skills. In contrast, the script-dependent hypothesis suggests that there is no assurance that a child's ability to read in one language is transferable to a second language. Each language develops separately from other languages (Gholamain & Geva, 1999; Liberman et al., 1974; Lindgren et al., 1985). The hypothesis attempts to explain why decoding abilities are more easily acquired in some languages. The linguistic interdependence hypothesis is concerned with both written and oral language, but the script-dependent hypothesis is concerned with written language only.

One important point to consider is that applying the skills used in L1 to L2 may be inappropriate because the languages have different orthographies; for example, children learning to read in the transparent languages—Spanish, Turkish, Italian and German—show fewer difficulties in reading acquisition, and at the end of their first year of reading instruction, their reading accuracy skills usually reach ceiling (Lallier et al., 2014; Seymour et al., 2003), demonstrating that the demands of the reading process for transparent orthographies are much lower than for opaque orthographies. Every language has different orthographic challenges and different grapheme–phoneme mappings; therefore, literacy skills may not transfer to a language with different orthographic characteristics, which means the child must learn to solve orthographic problems for each language separately (Liberman et al., 1980). When learning to read in two different languages when one is opaque and the other transparent, such as English and Spanish, English learners need to apply the grapheme–phoneme rules to read the words and develop a sight vocabulary; even in Spanish as soon as the children learn the basic grapheme-phoneme correspondences, they can easily decode most Spanish words. Therefore, the regularity in Spanish allows grapheme–phoneme rules to develop faster or more independently.

Scholars such as Strauss (2008) and Yildiz-Genc (2009) stressed that the process of attempting to learn to read two languages is a challenge that involves certain obstacles. Bialystok (2007) elaborated that despite some similarities between two different languages, significant differences also exist between them, which manifest during the development of the cognitive skills required for reading. According to Hussien (2014), learning a second language improves literacy skills in the first language because it enables learners to understand metalinguistic skills.

Metalinguistics means thinking about the nature and functions of language (Bialystok, 2001; Pratt & Grieve, 1984). Thus, exposure to more than one language might lead to the development of metalinguistic skills. According to Bialystok and Barac (2012), children who know two languages have a higher level of metalinguistic awareness than those who know only one language. This is likely because bilingual children's knowledge of two languages enhances their comprehension of language structure and overall language analysis abilities.

Jasińska and Petitto (2018) found that monolingual children had a weaker phonological awareness than bilingual children. Bilingual children who had been exposed to their second language at an early age outperformed their monolingual counterparts on measures of phonological awareness; their phonological abilities were found to be the strongest predictor

of reading ability, and they outperformed their monolingual peers on reading tests. The vast majority of research has shown that bilingual children have an advantage over their monolingual counterparts in phonological abilities (Goldstein & Bunta, 2012; Kang, 2012; Kovelman et al., 2008; Souza & Leite, 2014). However, Chiappe and Siegel (1999) utilised phoneme deletion and substitution tasks in their research and found no statistically significant difference between monolinguals and bilinguals.

Cummins' (2001) view on the relationship between L1 and L2 development in his development interdependence theory claims that cross-linguistic transfer can assist in the development of academic skills and cognitive abilities. Cummins claimed that if a minimal threshold of L1 cognitive and academic development is met, the cognitive and literacy abilities learned in L1 will transfer across languages. To elaborate on this, reading in the first language may be a source of knowledge and learning in the second language, as well as continuously improving the first. The threshold hypothesis postulates that to gain any advantages from using a second language, a learner must meet a minimal threshold in skill in that language. This indicates that if the learner does not meet the cognitive proficiency level in L1, achieving bilingual proficiency may be challenging.

1.2 English Language and Literacy Skills in the KSA

Speaking English is increasingly viewed as important in the job market in the KSA. In university departments, knowledge of English is necessary for most jobs and is often an entry requirement for students. English has a strong and perceptible presence in Saudi education. In Saudi Arabia, English is the primary and only foreign language taught as a core subject in public and most private schools. 'In Saudi Arabia, although Arabic is still used as the medium of instruction in all public primary schools, however, many private primary schools use English as a medium of instruction' (Al-Qahtani & Al Zumor, 2016, p. 18). In addition to public and private schools and universities, a wide range of businesses and government organisations provide direction in the English language.

In parallel to this, a number of changes have been implemented by the Saudi government in recent years to improve the English proficiency of Saudi students. English was introduced in the first grade in September 2021 according to the Ministry of Education. This helps pupils develop their linguistic abilities at an early age. In 2013, access to international schools was expanded as part of the Saudi educational system's overall effort to extend students' exposure to English. Attending international school was available only to non-Saudi students prior to 2013. Thousands of Saudis have also taken advantage of a government scholarship

programme to receive undergraduate and postgraduate degrees in English-speaking countries (Moskovsky & Picard, 2018).

The English language, which has marked its presence in virtually every home through television and the internet, is continually motivating young Arabs who attend private/international English schools to improve their English. Parents are choosing to integrate English education for their children by enrolling them in English-speaking schools, as it is believed to provide opportunities for employment and a wider range of universities (Al-Qahtani & Al Zumor, 2016). In public schools, children were introduced to English in Grade 4, but in line with Vision 2030, this was changed to Grade 1 in 2021. The data for the current studies were collected before 2021 and the participants were from Grades 3-6.

All Arabic subjects are taught in public and private monolingual schools following the curriculum of the Ministry of Education, with English as a single subject and not as a medium of instruction (more information regarding the differences between international and private schools can be found in section 3.4.1). Ninety-four percent of students who graduate from public schools require a foundation year before going to university (World Education News and Reviews (WENR), 2020) to reach the required proficiency in English, as English has become the medium of instruction in some universities and in most private universities. This shows that graduates of public schools do not have high proficiency in English (Al Mukhallafi, 2019). Today, English proficiency is considered not only prestigious but also a necessity for advancement in one's career and a gateway for Saudis to become more integrated into the worldwide community. While English is a crucial part of academia, higher education and the job market, it is also necessary in international communications, business and all fields involving science and technology.

Recent controversy has arisen as to whether it is appropriate to provide science and mathematics subjects in English for public school pupils so that they will have better opportunities to advance to the university level, where English is frequently utilised. Higher education thinking is to reduce the gap between public schools and international schools in using the language (WENR, 2020). Further, some universities, such as King Abdulaziz University, King Fahd University of Petroleum and Minerals and King Abdullah University (KAUST), ask for an international English language test, such as TOFEL or IELTS, as an entry requirement. English is the main language at universities in Arab countries in fields such as medicine, engineering, technology and science because textbooks and articles are written in the English language. Additionally, English has been used as the medium of

teaching in certain private universities, such as Dar Al-Hekma University, Alfaisal University and Prince Sultan University. As parents think about their children's futures, many prefer to enrol them in international schools to prepare them to meet university requirements. As a consequence of this, English is prominent in schools in the KSA.

1.3 Purpose of the Studies

The main aim of the current study was to explore the relationship between phonological processing and reading skills in Arabic and English, starting with typically developing bilingual children and then moving to those who have reading difficulties but have not been diagnosed with standardised assessment tools. Due to the lack of standardised assessment in the KSA, there are difficulties in identifying, assessing and being aware of learning difficulties among primary school students in the KSA.

1.4 Rationale for the Choice of Research Topic

This thesis examines reading and reading-related skills in typically developing children and children with reading difficulties who are learning to read in Arabic and English, as well as monolingual Arabic-speaking learners, in Grades 3–6. In contrast to English, Arabic is a Semitic language, and all languages are different from one another. Consequently, English findings may or may not generalise to Arabic. In most of the studies, variables that represent some kind of phonological processing and a limited number of reading measures for native Arabic speakers focused on the role of components of reading in the Arabic language. Far fewer studies have examined the role of phonological processing in bilingual Arabic–English readers and reading skills for typically developing children (Abu-Rabia & Siegel, 2002; Saiegh-Haddad & Geva, 2007). Even fewer have investigated the phonological processing and reading skills of Arabic–English children with reading difficulties (Elbeheri & Everatt, 2007; Mahfoudhi et al., 2011). There is limited research on reading difficulties in languages other than English (Share, 2008). Such research is now increasing and leading to collaborations between researchers from different countries. It is beneficial for studies on dyslexia to be conducted in a language that has a different orthography than English to understand how the nature of reading difficulties may differ across languages.

Phonological processing abilities have a significant role in the development of reading accuracy and efficiency; hence, they directly influence the development of reading ability (see Section 2.2 for more details). For typically developing children, there is substantial evidence in the literature that PA and RAN influence the development of literacy skills in children studying L1 or L2; however, the degree of this association varies based on the

consistency of the orthography. In addition, there is evidence that the majority of individuals with dyslexia have phonological difficulties and that phonological processing underlies word reading (see Section 2.5). The current thesis examines the degree to which phonological processing skills predict reading both within and across languages, examines how educational experience affects Arabic reading skills, and focuses on a small bilingual reading difficulties group to see how they differ from an age-matched typically developing group (TD). Sections 2.2, 2.5, 2.9 and 6.4 provide further explanations for why the current studies are focused on phonological processing skills.

Both the Arabic and English languages have an alphabet that is based on the principle of linking written symbols with basic sounds. Fourteen consonants are shared between English and Arabic (d/, /b/, /t/, /j/, /f/, /z/, /ʃ/, /h/, /l/, /m/, /n/, /w/, /r /and /y). Both languages are established through a consonant and vowel system. All of this suggests a reason to look at phonological processing in bilingual children who speak Arabic and English. More about the Arabic phonology differences can be found in Section 2.3.

1.5 Structure of the Thesis

This thesis consists of seven chapters. Chapter 1 provides an introduction to the field and a rationale for the studies described in this thesis. Chapter 2 reviews the literature on reading development theories and the skills needed for proficient reading; it discusses the structure of the Arabic language and the definition of dyslexia based on the theories of developmental dyslexia and bilingual readers before examining cross-linguistic skills transfer.

The methods used in the current work are summarised in Chapter 3, along with details about the test's adaptation into Arabic, data analysis, sampling (participants) and research ethics. Chapter 4 presents Study 1, which focuses on typically developing bilingual children compare them directly with the monolingual Arabic children's. Chapter 5 describes Study 2, which investigates reading and phonological skills in bilingual children with reading difficulties. Chapter 6 brings together and discusses the findings from all two studies presented in Chapters 4 and 5, and concludes with the limitations, practical implications and overarching conclusions of this work.

Chapter 2 Literature Review

2.1 Typical Reading Development

There are many skills and processes involved when a child learns to read. According to the simple view of reading (Gough & Tunmer, 1986), these can be simplified into two basic components: word recognition (decoding) and linguistic comprehension.

Decoding is about accessing the pronunciation of words from their printed form, although accessing the phonology can, of course, give the reader access to the meaning (Gough & Tunmer, 1986). Enhancing decoding skills means building a strong foundation for reading (Rayner et al., 2001). Skilled readers recognise words as wholes efficiently and automatically; that is, they do not need to laboriously decode each letter but recognise them as a unit (Adams, 1990). Linguistic comprehension refers to the ability to understand lexical knowledge (word level) and extract phrase and discourse meanings, and it encompasses all these things (de Jong & van der Leij, 2003; Gough & Tunmer, 1986).

Although there are different contributions to the reading process made by decoding and linguistic comprehension, neither is enough on its own. If a reader has good linguistic comprehension but trouble decoding, it is not possible to recognise the words to unlock their meaning. The ability to read can therefore be predicted through an examination of a reader's decoding and linguistic understanding (Tunmer & Chapman, 2002). However, several studies have shown the independent contribution of encoding and linguistic comprehension (Aaron et al., 2008; Catts et al., 2003; Savage & Broek, 2009; Vellutino et al., 2007). Evidence that decoding and language comprehension are different reading components is apparent in their separated relationship for a reader with dyslexia who shows good language comprehension but weak decoding skills (Aaron et al., 1999).

There are theoretical, educational and diagnostic consequences of the simple view of reading: it may help adapt teaching strategies for children, and it may help in assessing and diagnosing children with reading difficulties (Kendeou et al., 2009; Stuart et al., 2008). It follows that if children have difficulty decoding what they read, this will affect their understanding. Likewise, if children have a poor understanding of language, their weak semantic knowledge may result in poor reading of words, particularly if the words are uncommon or spelled irregularly (Nation & Snowling, 1998). If they do not know a word (well), it will be harder for them to read it accurately and fluently.

Gough and Tunmer (1968) proposed that the balance of influence of decoding and linguistic comprehension on reading comprehension changes with reading proficiency and grade level. In the early stages of learning to read, decoding, rather than linguistic comprehension, is likely to have a greater influence on reading comprehension (Perfetti, 1985). The logic is that although beginner readers have linguistic comprehension skills, they have to learn how their particular writing system represents their spoken language; that is, they have to learn to decode first. Hence, the faster letters and words can be processed during reading, the greater the cognitive resources available for higher-level comprehension processes (Cunningham & Stanovich, 1997). Thus, when word reading becomes relatively fast and automatic, a greater proportion of these processing resources can be devoted to reading comprehension.

Children need to grasp the alphabetic principle that letters correspond to sounds. When students realise that letters represent the sounds they say, they gain an understanding of the purpose of the alphabetic code, or the alphabetic principle (Treiman, 2000). They can therefore read a large number of words accurately, including words they have never encountered in text; for example, ‘went’ can be read using phonological decoding because the letters follow consistent grapheme–phoneme correspondences. In addition, children need to deal with irregular words as a visual unit (i.e. by sight), as they contain letters that do not follow letter–sound correspondences. Some English words have irregular orthography–phonology mappings, such as ‘yacht’, which means they cannot be read accurately using phonological decoding because of their inconsistent orthography–phonology mappings. Children have to learn these words by sight and recognise them this way.

Therefore, an important aspect of reading development is maintaining the ability to read words fluently and automatically (Murray, 2016). It is important to assess both decoding (the best way to do this is nonword reading) and sight word reading (the best way to do this is with irregular real words), as this provides vital information about the extent of the difficulties the student faces (Wagner, 2008). Sight words refer to ‘all words that readers can read from memory’ (Ehri, 2005, p. 135). Thus, children need to acquire the skills underlying decoding as well as develop their sight vocabulary to become successful word readers. An overview of some standard theories of how reading develops is presented in the following section.

2.1.1 Theories of Reading Development

Some models of reading development propose distinct stages or phases of reading, indicating that children progress as they learn to read. Consideration of how typical development reading is acquired may prove crucial to fully understanding the difficulties associated with it. Moreover, a reading model is helpful in describing abilities essential for reading, such as decoding. A model of reading development is an important tool that shows the achievements a learner is making as they learn to read.

Frith's (1986) model envisages three stages of reading development: logographic, alphabetic and orthographic. The logographic reading stage explains the process by which learners identify a word using visual and contextual characteristics. Young children start to recognise the shape or size of a word and treat it as a picture based on its salient features. For example, young children see the M logo for McDonald's and can recognise the subsequent word. A child at this stage is unable to read any unfamiliar words or nonwords. Ehri (2005) provided additional support for Frith (1986) logographic phase of development. Bielby (1999) suggested that children at this early stage are not conscious of the alphabetic principle and so do not understand that each grapheme corresponds to certain sounds. The age of children in this phase usually ranges from three to five years.

To begin Frith's second stage, the alphabetic stage, children first need to know the letters and their sounds. This then permits sequential decoding of unfamiliar words by applying knowledge of individual sounds and their corresponding letters. The child utilises the grapheme–phoneme conversion strategy and learns to read unfamiliar words and nonwords. Through their growing understanding of the alphabetic principle, the child can decode common words and nonwords. However, this strategy is not effective for reading the irregular words that abound in English. This strategy is a slow process, and it is the decoding itself that is slow and laborious because children have to translate each grapheme into a phoneme, and this takes a long time in the early stages.

Finally, in the orthographic stage, visual orthographic skills develop, which allow word recognition based on a systematic analysis of words into orthographic units. In this stage, the reader becomes more automatic in decoding the words using the alphabetic principle, and they begin to detect and use morphological orthographic patterns, such as the orthographic chunk of 'ight' or 'ough'. In this phase, the process of learning to recognise letters becomes more fluent and accurate. Frith's three-stage model posits that word reading and spelling are

useful as support systems for each other. In contrast to a stage model, readers do not have to complete one phase before using another reading method.

Ehri (1995) phase model of early reading development identifies four phases in this process: the pre-alphabetic, partial alphabetic, full alphabetic and consolidated alphabetic. It addresses some of the criticisms of stage theories (Ehri 1995, 1999, 2002, 2005), as it accounts for both the flexibility and variability of approaches that children display in the early phases of word reading. It highlights the importance of reading sight words through all reading phases, not just at later stages. Ehri (1998) identified four different phases of word reading that characterise beginning readers: (a) explicit phonological decoding, (b) the application of GPC rules, (c) the use of larger phonological units (e.g. analogies and morphological rules) and (d) the ability to predict words from those already stored in memory (indicative of sight word reading). Ehri (2005) claimed that the best way to become a skilled reader is to learn to read words by sight, which allows for reading a word as quickly as a single digit (Ehri, 2005).

However, readers may not be consciously aware that they are engaging in sight word reading. Ehri and Soffer (1999) proposed a mediated phase model that categorises readers according to their development. The phases reflect different reading and spelling strategies. These phases can help identify 'poor' readers and diagnose reading difficulties early (Ehri & Soffer, 1999).

Ehri's (2005) first phase is the pre-alphabetic phase, in which readers are able to recognise words visually based on their shape, pictures in storybooks or colours; this is comparable to Frith's (1986) logographic stage. In support, Beech (2005) examined which letters five-year-old children in the pre-alphabetic phase were able to recognise, and found that even though they could hardly read any of the sight words, they recognised their own and some of their classmates' names. When asked how they recognised their name, many said they knew the first letter. This demonstrates that the child can recognise words without having an understanding of the relationship between graphemes and phonemes. Hence, they only recognise the shape of the first letters of a word, and because of their limited knowledge of the alphabet system, they cannot decode and understand novel words (Beech, 2005).

In the full alphabetic phase, children read by forming associations between familiar letters and producing complete sounds. In this phase, they have acquired full knowledge of the alphabet and more advanced phonological knowledge. Their nonword reading ability is good

because decoding can be done using GPC rules. During the full alphabetic phase, children use sight word reading extensively for familiar words, and they can read unknown words (Stuart & Coltheart, 1988). In regard to both the partial phase and full alphabetic phase of reading, Ehri and Wilce (1987) tested readers experimentally. The readers were paired and placed into one of two groups. One group (partial alphabetic) was trained for 5–11 sessions to decode nonwords for 20 minutes each. The second group (full alphabetic) was instructed in and trained for 2–3 sessions in the GPC mappings. The partial alphabetic group could not yet read any of the words at the end of the task, but most of the words could be read by the full alphabetic group. The partial alphabetic readers made several mistakes in reading similarly spelled words. Full-phase readers learn sight words faster and more accurately than partial phase readers, and their spellings are better retained in memory.

Finally, the consolidated alphabetic phase develops during the full alphabetic phase. It progresses with a greater understanding of phonology and the person in this phase can group words with common patterns as units, e.g. the word ‘chair’ may be processed as two units, ‘ch’ and ‘air’, rather than ‘ch’, ‘ai’ and ‘r’ as in the previous phase. During this final phase, words are accessed much more quickly, and sight word reading is the most effective strategy for reading words that are already familiar. The use of analogy to decode and pronounce a novel word emerges as a new strategy. In this phase, specific strategies can be used to read different types of words. With respect to nonwords, the reader can apply phonological knowledge to map the graphemes to phonemes to produce a pronunciation or use analogy, breaking down and analysing word parts. Skilled readers typically read exception words via sight word reading (retrieval) or the application of GPC mappings (Snowling & Hulme, 2005).

Ehri’s (1995, 1999, 2002, 2005) phases of development indicate that children can differ in the way they read different words and that mastery of one phase may not be necessary for progressing to the next. Ehri claims that the goal of reading is to achieve sight word reading, the most efficient way of reading in English, as decoding errors are common in reading because so many words have irregular spellings. Ehri’s phase model is flexible and explains how children rely on sight word reading; they can only use sight word reading when they have a well-established orthographic lexicon. In comparison to Share’s (1995, 1999) approach, Ehri’s phase model focuses on analysing differences in words from a general perspective in the development of reading rather than at the individual word level.

Although stage models, and to a lesser degree phase models, have their limitations, Ehri's model recognises that children are not required to follow the sequence of phases in a strict manner; therefore, the model is flexible (Beech, 2005). Based on the data of the consolidated alphabetic phase focusing on children in their first year of school, the final reading stage can be accomplished at a very early age. Beech notes that this is not a development of reading that continues into adulthood. There is also no mention of the development underlying any cognitive structures relevant to the developing reading process, such as teaching style and how it interacts with phases. Nevertheless, Ehri (1999) argued that the phases are flexible; therefore, it may be possible to accomplish the consolidated alphabetic phase with short words, but longer words and unfamiliar words almost always require an earlier phase for decoding to achieve an effective result.

Share (1995, 1999) took a radically different approach by moving away from stage models. According to his self-teaching hypothesis, phonological recoding, or decoding, takes place when a child needs to read an unfamiliar word by applying grapheme–phoneme correspondence rules. Decoding provides an opportunity to think about and learn a word's orthography. Therefore, developing orthographic representations of words cannot occur without phonological recoding. Every time a child successfully decodes a word, they create that word's new word-specific representation. In this model, phonological recoding is a self-teaching mechanism that enables the child to independently develop both word-specific and general orthographic knowledge essential to skilled reading. According to Chung et al. (2019), the self-teaching hypothesis incorporates changes in orthographic representations to elucidate the development of reading processes and explain differences in reading strategies according to the words' nature.

The difference between Share's and Ehri's models is that Share's model views words at an individual level and does not cite any phases of reading development for children as they learn to read new words. Nonetheless, when combined, both Ehri's and Share's models of reading provide insight into word representation and retrieval processes when the learner encounters the same written words again. This means that although Ehri's approach may be used to examine general cognitive shifts in reading, Share's model can be used to look at the development of attributes and how high-frequency words may be mastered before low-frequency words. Ehri suggests that in the process of decoding a word, a child makes use of any means available to them. In 1999, Share observed that a child would encode a word just as they could sound it, such that the orthographic processing and retrieval process were not

precise in their internal lexicon. For example, if a child were to write the word ‘cat’ and sound it out to write from their internal lexicon, they could end up spelling it as ‘kat’ due to the sound confusion between ‘c’ and ‘k’.

All previous models of development focus on the development of children’s early word recognition skills. The next section focuses initially on the importance of cognitive processes for skilled readers.

2.2 Underlying Cognitive Processes for Proficient Reading

The utilisation of phonological information in the processing of written and oral language is known as phonological processing (Wagner & Torgesen, 1987). Geva and Willows (1993) and Adams (1990) established that children who have strong phonological processing skills tend to be good readers. Phonological processing is a cognitive ability involving phenomes to develop spoken/written language, and it affects reading development (Anthony et al., 2007; Torgesen et al., 1994; Wagner et al., 1993). The three main types of phonological processes suggested by Torgesen et al. (1994) are PA, RAN and PM, all of which are considered essential for developing strong word reading skills. The three components are discussed individually in the following sections. These components of phonological processing are important for word reading because the ability to translate the sounds of oral language into printed letters facilitates word decoding for children with strong phonological awareness (Adams, 1990). Reading becomes easier with an efficient phonological memory system because cognitive resources can be directed towards blending the sounds together to form words rather than finding a strategy to remember them (Baddeley, 1982).

Rapid automatised naming calls upon a range of cognitive processes that readers perform automatically when decoding words. Long-term memory must be accessed rapidly to obtain the letters’ phonological codes; the letters’ codes must then be blended and the meaning searched for in the long-term memory’s internal dictionary (Wagner & Torgesen, 1987). Each of these processes is addressed in the following sections. The phonological processing components are crucial for enabling and facilitating accurate and fluent word reading. Learners with good phonological processing skills can analyse, manipulate and differentiate the sounds of a language. Wagner and Torgesen (1987) stated that there was a link between different phonological processing abilities; for example, performance in PA tasks is dependent on performance in PM tasks.

However, there is some evidence to suggest that these abilities are somewhat separate from one another. Mann and Liberman (1984) observed that the relationships between various phonological processing abilities were insignificant, and they accounted for independent variance in explaining reading skill. This shows that during reading development, these phonological processing skills can work independently. Kibby et al. (2014) suggested that reading requires much more than just phonological processing and that verbal working memory and attention management predicted reading ability.

There have been different perspectives on the relationship between phonological processing skills and reading. Some of these revealed different results, according to some researchers; all three phonological processing components (phonological awareness, phonological memory and rapid naming) account for unique variance in reading (Torppa et al., 2006). Other researchers have only revealed one or two of the three phonological processing components to be related to unique variance (De Jong & Van der Leij, 1999; Lonigan et al., 2009; Sprugevica & Høien, 2004). It has been demonstrated that the increased variance in fluency is due to an increase in automatised naming, whereas the variance in word reading is explained by phonological awareness (Høien-Tengesdal & Tonnessen, 2010). In fact, some researchers believe that the RAN task actually involves many different cognitive processes, including phonological processes (Georgiou et al., 2013; Savage et al., 2007). Scholars have shown that RAN accounts for a significant amount of variation in reading, above and beyond the influences of other measures of phonological processing, such as PA, PM or both of these (Fleury & Avila, 2015; Kirby et al., 2003; Powell et al., 2007).

Generally, there appears to be little consensus on the interrelationships involving phonological skills and the relationship between phonological processing and reading. According to Wagner et al. (1997), depending on the degree of regularity of phoneme–grapheme correlation in various orthographies, the relative contributions of phonological processing abilities to reading may change between languages. In the next section, PA, PM and RAN are discussed, including how they relate to reading.

2.2.1 Phonological Awareness (PA)

Goswami and Bryant (1990) described phonological awareness as the ability to perceive and modify sounds in words, which is important for learning to decode. PA refers to the awareness of the sound structure of words in oral language and has been shown to be strongly linked to subsequent reading and spelling skills (Yopp & Yopp, 2009). Further, Trehearne and Healy (2003) stated that phonological awareness is the understanding of a language's

sound structure, consisting of words, syllables, rhymes and sounds (phonemes). The phoneme is the smallest unit of sound in a word, allowing for pronunciation and contextual variations between words (Adams, 1994). PA progresses from the awareness of large units (syllables and rimes) to the awareness of small units (phonemes; Anthony & Francis, 2005). The relationship between PA and reading is complex and reliant on a wide variety of factors, including the characteristics of the task, the developmental level of the individual, and orthographic complexity (Castles & Coltheart, 2004; Landerl et al., 2019; Thomson & Goswami, 2010).

Evidence suggests that PA is typically linked to learning to read and that children's progress in reading skills relies on their phonological awareness (Gillon, 2005; Goswami & Bryant, 2016). Phonemic awareness develops in conjunction with learning to read an alphabetic orthography, so before they start learning how to read, it is very unlikely that children will show phoneme-level PA (Yopp, 1992). Specifically, without phonological awareness, children cannot understand the alphabetic principle and thus fail to apply the phonics instruction they have received. Phonics involves the correspondence between sounds and components of their spelled words; for example, the sound *f* can be spelled as f, gh or ph (Adams, 1994). Fortunately, direct phoneme-level instruction along with alphabet instruction supports reading skills and the development of phonological awareness (e.g. (Ehri, Nunes, Willows, et al., 2001; Phillips et al., 2008).

Once children acquire phonemic awareness and the alphabetic principle, they start to read more fluently. Phonemic awareness is one aspect of PA. Phonemic awareness is a sub-skill that is included under phonological awareness. A longitudinal study by Bryant et al. (1989) aimed to establish the links between children's early knowledge of nursery rhymes and their progress in reading and spelling several years later. The researchers followed the progress of 64 British children aged between three and six years on measures of reading, spelling, PA skills (rhyme detection, phoneme awareness) and knowledge of nursery rhymes. The results showed that the children's early knowledge of nursery rhymes was closely related to the development of PA skills over a period of three years, which in turn was related to their success in reading and spelling. The researchers suggested that a possible explanation for this might be that children's early knowledge of nursery rhymes enhances their sensitivity to rhyme and alliteration, which in turn facilitates the development of their PA skills. These findings are compatible with the claim that rhymes, which involve large phonological units,

are easier to segment for young children than small units of sounds (phonemes) and that such knowledge is necessary for the subsequent development of phoneme awareness.

In Arabic, Tibi (2010) investigated the developmental hierarchy of four different Arabic PA tasks (identification of initial sounds, rhyme oddity, syllable deletion and phoneme segmentation). Tibi (2010) observed that the identification of the initial sound in the word and rhyme oddity was relatively easier than syllable deletion and phoneme segmentation constructed on the PA training data of 140 native Arabic children ranging from the first to third grades. This is in line with the hierarchical sequence in which PA skills typically develop during childhood in English-speaking children. These findings provide credibility to Saiegh-Haddad's (2007) declare that it is more challenging to learn single phonemes than to master larger syllables. Based on these findings, it appears that efficient Arabic language learning should comprise practice with a variety of phonemic patterns associated with roots rather than focusing on single phonemes.

Phonological awareness, particularly at the phoneme level, plays a direct role in decoding and spelling. It is clear that phoneme-level awareness is related to decoding and encoding in alphabetic writing systems because graphemes (letters) represent phonemes (sounds) in written words. That is, knowledge of phonemes and the alphabet enables children to understand the mapping of graphemes onto phonemes to form spoken words (Adams, 1990; Share, 1995). Furthermore, the findings of a short-term longitudinal study (Hulme et al., 2002) indicated that phonemic awareness was a stronger predictor of word reading performance than onset-rime awareness. Seventy-two children aged 5–6 years were assessed on three PA tasks (deletion, oddity and detection) at the phoneme and onset-rime levels. The results revealed that the measures used to test PA at the phoneme level were significant longitudinal predictors of children's early reading skills, unlike the measures of the onset-rime awareness level, which did not make much of an extra contribution compared to the phonemic skills.

Ziegler and Goswami (2005) claimed that there are three determinants of the type of phonological awareness that is important in learning to read, and that they influence the strength of the relationship between phonological awareness and reading ability across different languages. These three determinants are (1) the linguistic grain size (or granularity) with which phonology is mapped onto orthography in a particular language, (2) the consistency of this mapping, and (3) the availability of this linguistic level in spoken

language (e.g. Goswami, 1999; Ziegler & Goswami, 2005). Each of these will be explored in more detail.

Since the child cannot distinguish individual phonemes in the speech stream if they have not yet learned to read, the availability issue arises. Young children, for example, may not have clear access to phonemes, which are the smallest identifying features that allow two words in a language to be separated. Since phonemes are components of spoken language that are seldom accessible as distinct units due to coarticulation, attending to them necessitates a high level of abstraction (Ziegler & Goswami, 2005). As a consequence, linking orthographic units to phonological units that are not yet available requires additional cognitive development. Phonemes are articulated in a single articulatory gesture within each syllable rather than one at a time.

That some orthographic units have multiple pronunciations, such as '*ea*' in *tear* and *lead*, and some phonological units have multiple spellings (e.g. *rose* and *rows*), raises the consistency question (Ziegler et al., 1997). Both forms of inconsistency are thought to slow the progress of reading skills. It is worth mentioning that the degree of inconsistency differs across languages and across various forms of orthographic units. This variety means that the rate of reading development can vary between languages. For instance, distinguishing between phonemes may result in the change of meaning evolving earlier in Spanish, a language with more highly consistent sound–symbol relationships, than in French, a language with more spelling and pronunciation inconsistencies, or English, which has even more inconsistencies (Goswami et al., 1998). The characteristics of English orthography render it a deep orthography, with erratic and ambiguous letter–sound mappings, such as the phoneme 'k', which can occur as several graphemes in words like car, thick, opaque and kite. In more straightforward orthographies, grapheme–phoneme correspondence skills are more relevant to phonological recoding.

Finally, the granularity problem highlights that since access to the phonological system is based on larger grain sizes rather than smaller grain sizes, there are far more orthographic divisions to learn. That is, there are more words than syllables, more syllables than rimes, more rimes than graphemes and more graphemes than letters. The resolution of these three issues—granularity, consistency and availability—is important for reading proficiency (Lim et al., 2020). The observed rate of reading acquisition across languages is consistent with the prediction that learning to recode orthographical sound symbols for orthographically opaque

languages like English and French takes longer than for orthographically consistent languages such as Spanish and Italian.

Ziegler and Goswami (2005) formulated the psycholinguistic grain size theory as a basis for studying the effect of cross-linguistic differences in orthographic transparency on reading development. According to this theory, reading accuracy and speed differ across orthographies because of fundamental differences in phonological recoding and reading strategies. Grain size can vary from words to syllables, onset and rime, and phonemes (from largest to smallest grain sizes; (Goswami, 2010). Based on psycholinguistic grain size theory, for a less consistent orthography, children have to learn to use flexible grain sizes, which takes place only after systematic teaching or learning begins.

Some studies (Anthony & Francis, 2005; Landerl & Wimmer, 2008; Papadimitriou & Vlachos, 2014; Vaessen et al., 2010) have indicated that PA can play a different role in the development of reading skills in different orthographies, but other studies, such as Caravolas et al. (2012), have shown that predictors are consistent across orthographies. For example, Georgiou et al. (2008) investigated the simultaneous and longitudinal predictors of word decoding and reading fluency among children in Grades 1 and 2 who learned to read in an inconsistent orthography (English) and a consistent orthography (Greek) and measured their phonological awareness, phonological memory, rapid naming speed, orthographic processing, word decoding and reading fluency. The researchers reassessed the same children on word decoding and reading fluency measures when they were in Grade 2. Phonological and orthographic processing contributed independently to reading ability in Grades 1 and 2. In English, phonological awareness and orthographic processing were the best predictors of word decoding, and PA predicted reading accuracy better than RAN. However, in Greek, RAN was the best predictor of word decoding. According to the researchers, both phonological and orthographic processing skills are important in early reading acquisition, although the characteristics of the language moderate the effects of phonological and orthographic skills in the early stages of reading development.

There may be predictable patterns of reading skills across different orthographies. Caravolas (Caravolas et al., 2013; Caravolas et al., 2012) demonstrated consistency in predictors across orthographies varying in depth. The findings on the predictive role of PA and RAN across orthographies were inconclusive, but recent longitudinal studies (e.g. Landerl et al., 2019) have contributed to the knowledge of the role of these skills across different orthographies. Landerl et al. (2019) examined whether PA and RAN predict reading

skills of children in Grades 1 and 2 in five different orthographies (English, French, German, Dutch and Greek). Path analyses suggested that RAN was the best predictor of reading fluency in all orthographies, whereas the correlation between PA and reading fluency was complex, as only one language (French) demonstrated the classic view of PA as a predictor of reading. However, there was a clear reciprocal association between PA and reading fluency, with the associations occurring throughout the full study period in both directions. A reciprocal pattern also occurred between PA and reading in English and German from the end of Grade 1 to the end of Grade 2, while the prediction for PA from Grade 1 to Grade 2 was unidirectional in Dutch and Greek, as reading predicted PA but the reverse was not shown. They concluded that orthographic depth affects the relationship between PA and reading fluency, with transparent orthographies unidirectional and opaque bidirectional. However, it should be noted that the groups differed in terms of reading instruction. The German children had not yet learned to read at time 1, while the French and English children had advanced reading skills. Nevertheless, certain aspects of PA may emerge before or independently of reading instruction (e.g. larger unit size—onset—rime/syllable awareness), while phoneme awareness tends to be bidirectionally related to reading from the start.

Phonological awareness training seems to be more successful when paired with direct teaching that shows children the links between language sounds and the letters that represent certain sounds (Bradley & Bryant, 1983).Ball and Blachman (1991), for example, randomly allocated 90 children from kindergarten to one of three groups: (a) a phoneme recognition group, who received instruction in segmenting words into phonemes as well as sound-letter correspondences; (b) a language activities group, who received only sound-letter connection training; and (c) a control group, who received no intervention. The intervention was administered in the spring of the kindergarten year and consisted of seven weeks of a small group (five students) who received teaching with four 20-minute sessions a week. The results revealed that the training group performed better on tests of reading, spelling and phoneme awareness than the language activities group and the control group. The findings showed that kindergarten learners should be taught phoneme segmentation and that this information can be applied to items that were not previously taught. Furthermore, the phoneme recognition group outperformed the other two classes on the reading and spelling tests. Teaching letter–sound connections alone was ineffective in improving phoneme segmentation skills, and it was also ineffective in improving beginning reading skills. Segmentation skills must be taught alongside letter sounds. According to Ball and Blachman (1991), any student with

reading, writing or memory difficulties must be specifically taught sound–symbol correspondences to learn phonological decoding skills.

To summarise, it is evident from the findings of previous studies that phonological awareness is associated with learning to read, and that reading development in children depends on their phonological skills. Further, through intervention, a bidirectional/ reciprocal relationship is established between reading and the development of phonological awareness. In different orthographies, phonological awareness might play a distinct role in the development of reading skills. The theory of psycholinguistic grain size relies on the assumption that phonological representational structures and phonological awareness skills of children depend on phonological and orthographic language structures. The theory highlights three crucial issues in mapping the word-reading acquisition process: availability, consistency and granularity.

2.2.2 Rapid Automatised Naming (RAN)

Denckla and Rudel (1974, 1976) were the first to use the RAN task and link it to reading development. They created timed naming tests with two types of stimuli: digits and letters or colours and objects (these were used with children 4–6 years old with less mature literacy ability). Differences in naming speed were found between various groups of children, especially those with reading difficulties and typically developing children. Since then, many studies have established that RAN is linked to the development of literacy, especially reading speed (Bowers, 1993; Clayton et al., 2020; Houlis et al., 2019; Young & Bowers, 1995). However, Wolf and Bowers (1999) argued that nonphonological aspects of RAN are also important in their link to reading development, such as speed of processing. RAN has been found to predict reading development independently of phonological awareness (Wolf et al., 2000), and performance on RAN tasks is correlated with reading fluency and efficiency (Wolf & Bowers, 1999). In general, RAN is a better predictor of reading efficiency than PA (Kirby et al., 2010). RAN is not only related to the initial developmental stages of reading fluency, it is also related to the later development of reading as a whole (van de Ven et al., 2017). Albuquerque (2017) demonstrated an important association between RAN and reading words, text and writing with Grade 3 and 4 students in Portuguese, and showed that RAN was more strongly related to reading fluency after controlling for PA.

A main argument given to incorporate RAN into one of the broader phonological structures is that the RAN task demands that the participant swiftly convert visual symbols from long-term memory to phonological codes (Wagner & Torgesen, 1987; Wagner et al.,

1994). Whenever a child is presented with a RAN stimulus, they look for a phonological representation of the visual stimulus before articulating it. Difficulty in RAN indicates a problem in recovering stored phonological representations effectively and automatically (Arnell et al., 2009). However, Norton and Wolf (2012) maintain that it would be inaccurate to subsume RAN under phonological processing because of this. Another view holds that although RAN contains a phonological component, it involves cognitive functions that operate independently. RAN letters and numbers represent the automaticity of the processing of orthographic symbols and can influence reading through the effectiveness of orthographic processing rather than phonology processing (Wolf & Bowers, 1999; Wolf & Bowers, 2000).

In both consistent and inconsistent orthographies, RAN is one of the strongest predictors of reading fluency skills (Di Filippo et al., 2006; Karadağ et al., 2019; Landerl & Wimmer, 2008; Roman et al., 2009). In addition, RAN is one of the strongest predictors of learning difficulties in general among children at risk for dyslexia in the English and Finnish languages (Catts et al., 2001; Puolakanaho et al., 2007; Torppa et al., 2012). As reading proficiency develops, the relationship between RAN and reading becomes reciprocal, meaning that RAN predicts reading speed, and when a person improves in reading speed, their RAN increases (Houlis et al., 2019; Powell & Atkinson, 2020). Powell and Atkinson (2020) revealed that in monolingual English preschool children, PA predicted word reading accuracy only, while RAN predicted word reading accuracy and fluency. RAN was also found to be strongly linked to both alphabetic decoding and lexical, orthographic aspects of reading. This could be because RAN is a complex activity that necessitates the integration of a variety of cognitive abilities, all of which are shared with reading, since studies have revealed moderate to strong associations between PA and RAN, and PA mediates the relationship between RAN and reading (Swanson et al., 2003; Wagner et al., 1999). In more consistent orthographies, on the other hand, PA has been shown to be less strongly and persistently linked to reading development. This is perhaps because phonological awareness seems to be more closely related to measures of reading accuracy than to reading fluency, which tends to asymptote rapidly in readers of consistent orthographies (Kirby et al., 2003; Moll et al., 2014; Wimmer et al., 2000).

The predictive capability of RAN varies with regard to the depth of a language's orthography. Landerl et al. (2019) found that in different languages with different orthographic consistencies (English, French, German, Dutch and Greek), the relationship between RAN and reading fluency is stable across reading development. Georgiou et al.

(2016) examined the relationship between RAN and reading fluency by contrasting phonological awareness, orthographic processing and speed of processing. The participants were Greek children in Grade 4, and the researchers measured their phonological awareness, digit and object naming, orthographic processing, speed of processing and reading fluency. According to the results, RAN was a strong predictor of reading fluency, and orthographic processing partially mediated this relationship when participants were instructed to read as quickly as possible. While RAN predicted phonological awareness, phonological awareness did not predict reading fluency. In transparent orthographies, children rely on GPC rules to read fluently, especially young children, while proficient readers rely on the whole word to read fluently (Araújo et al., 2015). RAN measurements are strongly correlated with the acquisition of reading fluency skills, which are critical to the effective acquisition of reading (Ibrahim, 2015).

In opaque orthographies, reading fluency develops more slowly than in transparent orthographies. Vaessen et al. (2010) examined the developmental association between cognitive abilities and reading fluency for different types of words (high-frequency, low-frequency, and pseudoword reading) and the modulating effect of orthographic consistency on this relationship in children in Grades 1 to 4 who spoke Hungarian, Dutch or Portuguese as their first language. The results indicated that phonological awareness has a significant impact on reading fluency in proficient readers and that the relative importance of PA and RAN on reading fluency changes with time as a function of reading experience, suggesting that cognitive contributions to reading development are largely independent of orthographic consistency. The authors argued that as children become more proficient readers, the effect of RAN on reading success rises. These findings do not support the argument that readers of transparent orthographies use cognitively distinct reading methods compared with readers of opaque orthographies.

In a longitudinal study of bilingual children's performance on RAN tasks, Savage et al. (2018) assessed the success of RAN in predicting reading skills in French and English, both of which are considered to have opaque orthographies. The 115 pupils were English–French bilinguals who were tracked in a bilingual programme from kindergarten to Grade 6. The study's longitudinal methodology, which employed a single cohort of English- and French-speaking children learning to read, provided insight into RAN's longitudinal predictive benefits. After controlling for various extraneous variables, the results indicated that while RAN was not a significant predictor of English reading fluency for pseudowords in Grades 3

and 6, it was an important predictor of word reading fluency in English and French. Even after adjusting for pseudoword reading fluency in Grade 6, this association remained significant. RAN may tap into processes beyond grapheme–phoneme correspondence fluency in English and French, according to Savage et al. (2018). In comparison, after correcting for pseudoword decoding fluency, RAN was an important predictor of French and English reading fluency in all grades for both words and pseudowords. Savage et al. (2018) claimed that reading-related learning resource utilisation associated with orthographic/phonological processing, as measured by kindergarten RAN, may be evident in later school grades, particularly Grade 6, once children's mental lexicons have developed, but not in younger children. RAN is a complex indicator of reading processes taking place in the bilingual context, with the extra complication of opaque orthography.

Nakamoto et al. (2007) investigated literacy development in bilingual English/Spanish students from Grade 1 to Grade 6 and revealed that RAN was associated with literacy development over time. Both high RAN and high PA were associated with faster reading development, while word decoding development for older children was expected to slow. Additionally, children with lower RAN skills showed poor reading accuracy in the initiation period of their study and gained weaker skills in this literacy outcome, indicating that for L2 children, RAN could be an early sign of bilingual children showing literacy difficulties.

Bowers and Wolf (1993) argued that PA and RAN can be independent causes of dyslexia. According to the double deficit hypothesis (DDH), dyslexia can be caused by a single phonological awareness deficit, a single RAN deficit or a double deficit. This will be discussed in greater depth in Section 2.5. In a longitudinal study, Kirby et al. (2003) observed that typically developing (TD) learners performed better over time, while students with phonological deficits performed poorly at first but gradually caught up to the TD students in later grades. The RAN group performed about as poorly as the double deficit group throughout. In terms of achievement, the double deficit group was more than two years behind the TD group and showed no prospects of catching up; the same was true for the RAN group. Deficits in PA and RAN play a major role in reading difficulties.

2.2.3 Phonological Memory (PM)

Phonological memory refers to the short-term ability to remember words over a specific timeframe, as measured by nonword repetition and digit span tests (Swanson et al., 2006). It has been argued that PM plays an important role in the long-term learning of new words and is also an important predictor of vocabulary acquisition (Gathercole, 1999; Gathercole et al.,

1997). Phonological memory has been shown to affect children's L1 learning (Michas & Henry, 1994). PM tends to play an important role in reading development when the relationships between letters and sounds are being acquired (Gathercole & Baddeley, 1990), and effective phonological coding of information helps the beginning reader to retain a correct description of the phonemes linked with letters or parts of words (Wagner et al., 1997).

The essence of PM's contribution to the development of reading skills continues to be nuanced and strongly reliant on reading proficiency (Gathercole & Baddeley, 1990). Beginning readers rely on an efficient storage system to crack the reading code in the early stages of learning to read, which places a greater demand on PM than later phases of learning to read (Wagner & Torgesen, 1987). Skilled reading, on the other hand, puts fewer demands on PM as the underlying components of reading, such as letter identification and alphabetic decoding, become more automated. This means that the pressure on PM is reduced (Engle et al., 1999; Numminen et al., 2002).

Poor PM may be one of the underlying causes of reading difficulties (Chiappe et al., 2000; Gathercole et al., 2006; Siegel & Ryan, 1989). Poor readers might have problems with the phonetic coding of information in their working memory. As PM capacity is limited, the retrieval facility may be unable to maintain information for processing, resulting in difficulty in producing spoken forms of written words. A faulty PM has been attributed to both poorly defined phonological representations and inadequate phonetic coding abilities (Numminen et al., 2002; Wang et al., 2011). The reading process is slowed by poor PM and phonological features of sounds are incorrectly encoded and easily lost in memory (Gathercole & Baddeley, 1993).

Reading achievement tests are closely associated with tasks that measure memory span and nonword repetition. Performance on memory span tests depends on it being difficult to encode and store spoken stimuli in the verbal memory system. As a result, short-term memory issues have a significant impact on participants' ability to do tasks that call for the storage and computation of the sounds in words, especially when they are engaged in complicated PA tasks like blending and segmenting phoneme (Dollaghan & Campbell, 1998; Gathercole et al., 1994). In a longitudinal study, Nation and Hulme (2011) investigated the relationship between reading and nonword repetition in a sample of 215 first and second graders. Nonword repetition can be influenced by decoding, even after the impacts of general oral language abilities and phonological awareness have been taken into account.

Although it has been claimed that phonological memory is necessary for the acquisition of vocabulary in children (Gathercole, 1995), a study by Wagner et al. (1997) failed to support the function of phonological memory in the development of reading, indicating that other abilities, such as letter knowledge and vocabulary, are better predictors of word reading in English, and further studies have found similar results (Melby-Lervåg, 2012; Metsala, 1999; Nation & Hulme, 2011). McDougall et al. (1994) examined the relationships between reading, phonological memory and phonological awareness skills among 7–9-year-old monolingual English children in the UK. Regression analyses showed that rhyme awareness, phoneme deletion and speech rate (but not verbal short-term memory) predicted reading skill independently, while PM did not. Therefore, in English, the role of phonological memory in reading is less well established than the roles of PA and RAN.

In Arabic, few studies have investigated the relationship between PM and decoding. Taibah and Haynes, (2011) examined whether PA, RAN and PM predicted the reading skills of Arabic-speaking children from kindergarten to Grade 3 onwards. Although PM measures were significantly correlated with word reading skills in Arabic, regression analyses showed that they did not account for unique variance in word reading over and above RAN and PA. In addition, these correlations were smaller than those of the other predictor variables, PA and RAN, with nonword repetition showing greater correlations than digit span. The digit span task did not correlate significantly with any outcome measures in Grade 3, while nonword repetition showed moderate correlations with reading fluency. So, while Taibah and Haynes (2011) suggested that PM is not an important predictor in Arabic reading, what needs to be considered is that during sounding out, children need to generate the sounds for the letters in a word and hold them in PM long enough to blend them. It is easy to see how PA and PM complement each other and work together in the process of reading acquisition, as described by Gathercole and Baddeley (1999). To blend and segment all phonemes inside a word that need to be connected to graphemes, knowledge of the phonological structure of the word is needed. This method necessitates the use of a storage device (the phonological loop, part of PM). Therefore, PM is necessary for containing GPC products that interact to produce word structures. Taibah and Haynes (2011) did not take into account that kindergarten and Grade 1 students were unable to read non-vowelised connected texts, which in turn caused difficulty in the process of comparing the reading ability of vowelised and non-vowelised text formats. Therefore, Taibah's study results could not entirely represent the influence of PM on children's primary reading skills.

Wagner et al. (1994, 1997) proposed that phoneme awareness and phonological memory stem from lexical representations. Their study followed over 200 children in the US from kindergarten to Grade 4 and showed that there was a relationship between phoneme awareness and phonological memory. To add to this, a meta-analysis of 135 correlational studies was carried out by Lervåg et al. (2012). Their evidence revealed that verbal short-term memory did not predict reading achievement and that phoneme awareness explained this relationship over the years of schooling. In addition to this, it was found that verbal short-term memory's impact on reading is almost entirely limited to phoneme awareness. However, the meta-analysis failed to distinguish between concurrent and longitudinal investigations and did not explore any alterations in association with time.

A recent longitudinal (five-year) study by Cunningham et al. (2021) investigated the link between PM and reading for children aged 4–9 years old. Phonological memory, word-level reading and phoneme awareness were assessed. The study illustrated how children's relationships with reading changed over time. In the first two years of school, tasks that involved serial order memory influenced reading ability, which shows that children must be able to recall and produce sounds in the correct order to learn basic decoding skills. Elementary-aged students are said to acquire sight word vocabulary during their second year of schooling, which then reduces the stress on serial order memory. The number of words a child uses increase with age, which enables them to create a sight word vocabulary and lessens the impact of a decoding method, thereby lowering the amount of memory required for serial order memory. Cunningham et al. (2021) also found that reading had a longitudinal effect on nonword repetition, especially through phoneme awareness. A direct link between reading skills and the ability to produce repeated nonwords suggests that a reader's ability to read increases their chances of directly using orthographic knowledge to remember previously unfamiliar things.

Additionally, the association between PM and reading appears causal. Several studies have demonstrated that phonetic coding efficiency is the outcome of how well children learn to read (Mann, 1984; Share et al., 1984). A causal connection suggests that the development of reading is a result of PM abilities. There is, however, evidence that while PM is strongly associated to reading achievement through the early years of reading instruction (Passenger et al., 2000), its involvement is not a causal component per se but part of the general phonological processing skills structure that is related to reading development (Wagner et al. 1997). Phonological memory and early reading performance are not independent of each

other because phonological memory and phonological awareness are associated in nature. Phonological memory's contribution to reading ability may be mediated by phonological awareness (Näslund & Schneider, 1996).

2.2.4 Summary of Phonological Processing in Relation to Proficient Reading

Overall, studies with children demonstrate that the strongest predictors of word reading vary considerably. PA and RAN play an important role in the development of reading accuracy and fluency; hence, they directly influence the development of reading skill, while PM plays a much smaller role than PA and RAN (Demoulin & Kolinsky, 2016). For typically developing children, very strong evidence exists in the literature to suggest that PA and RAN influence the development of literacy skills of children learning L1 or L2, although the strength of this relationship varies with the consistency of the orthography. The influence of phonological processing (PA and RAN) depends on the consistency of the orthography, with less consistent orthography being associated with a weaker influence on reading fluency. However, to fully understand how predictors of reading accuracy and fluency vary as a function of orthographic transparency, it is essential to have a good understanding of the structure of the particular language being studied. The following sections introduce the Arabic language and discuss Arabic orthography.

2.3 Arabic Language and Orthography

The main language spoken in Arab countries located in the Middle East and North Africa is Arabic. It is estimated that approximately 200 million people in that area speak one of the 30 Arabic dialects as their first language (Versteegh, 2014).

2.3.1 Diglossia in Arabic

To completely understand the Arabic language, the term 'diglossia' must be understood. Diglossia is defined as the use of two forms of language within a single community (Ferguson, 1959). To have diglossia is to have two extremely different dialects of the same language being used in different contexts in the same culture. For instance, the Arabic word 'ذَهَبَ/zahaba' (went) is taught and encouraged in schools for use in more formal or literary contexts, such as formal writing, while the word 'راح/rah' (went) is used more casually in spoken conversation. In addition, Spoken Arabic varies depending on the dialect and the word 'rah' is commonly used in the Hejazi dialect. However, in other dialects, the word 'ذَهَبَ/zahaba' is spoken as 'طِلع /tela', such as in Egyptian, or 'غدى / ghada', as in Morocco dialects.

Before starting school, most children speak almost exclusively Spoken Arabic. Spoken Arabic varies throughout the Arab nations, and every nation has its own distinct dialect, as described in the example, which differs from the Saudi Arabian dialect. Since a large proportion of about 12.3 million Arabic words have a Standard Arabic form different from the Spoken Arabic form, it is likely to cause ambiguity and make it comparatively more difficult to learn to read in Arabic than in other languages.

The gap between Standard Arabic and Spoken Arabic poses a significant challenge. Saiegh-Haddad and Haj (2018) investigated the effect of the phonological distance between Spoken Arabic and Standard Arabic on the quality of phonological representations in children from kindergarten to Grade 6. One hundred and eight words were chosen that belonged to one of the three categories: 1/ identical words, with the same lexical-phonological form in Spoken Arabic and Standard Arabic; 2/ cognate words, with phonological forms partly overlapping; and 3/ unique words, which were totally different. The results showed that phonological distance had a significant impact on phonological representational quality for all children from kindergarten to Grade 6. The highest accuracy scores were found in distantly related words, while words that were familiar had the lowest scores, and words that were very similar had scores that were in between. The more similar and overlapping the Standard Arabic word was with the children's Spoken Arabic dialectal form, the easier it was for them to determine whether it was pronounced correctly. Accordingly, the dialect the child speaks and how similar it is to Standard Arabic are important. The children in the current study spoke varied dialects because they came from several Arab countries, including Saudi Arabia, Egypt, Syria, Jordan, Libya, Iraq and Sudan.

2.3.2 Arabic Phonology

The Arabic alphabet consists of 28 letters and 34 phonemes, with each letter corresponding to one phoneme. However, this does not apply to less common letters: أ،ء،ى،ؤ. The reason they are not counted is because they are compound letters: (ة/t) is a mixture of (ت/t) and (ة/t). أ،ء،ى،ؤ the hamza (ء) are essentially glottal stops spelled differently, and (ا/a) has the same pronunciation as (ى/a). When those additional less common letters are counted, there will be a total of 34. However, nobody claims that Arabic has 34 letters. Arabic has two types of sounds: consonants and vowels. The vowels are divided into long vowels, short vowels and diphthongs. The three long vowels are represented by letters and always appear in words (Abu-Rabia, 1996); they are ا'Alef' و 'wow' and ي 'ya'. Short vowels are the sounds (a/u/i) represented with diacritical marks above or below the letter, such as ba بَ / be بِ / bo بُ.

For young children learning to read, short vowels (diacritical marks) are essential. Diacritical marks are viewed as exterior to the word's structure. Children's literature, the holy Quran and poetry are the only places where short vowels are used. Short vowels are not used in literary works, magazines or newspapers. Arabic script with short vowels is not common in Arabic writing across Arab countries, including Saudi Arabia. Diacritics are taught to children as they begin reading. In the fourth grade, diacritical marks are gradually reduced (Abu-Rabia & Siegel, 2003; Ibrahim, 2013). There are two diphthongs: 'ay' and 'aw'. It is important to note that diphthongs in Arabic are distinct from other vowels, since, in essence, they are monosyllabic sounds that begin with one vowel and then transition to another.

Diacritical marks in Arabic are essential for distinguishing homographs when reading single words. Because all grammatical and morphological features are offered in diacritical markings, proper pronunciation should be activated automatically when a single word is provided vowelised (Schiff, 2012). Researchers have come to conflicting conclusions about the role of diacritical marks in reading accuracy. Some have found that diacritical marks are important for achieving optimal reading accuracy (Abu-Rabia, 2007, 2012), while other researchers agree that reading accuracy is not improved by using them (Ibrahim, 2013; Seraye, 2004). According to Saiegh-Haddad (2011), only children in the first grade with reading difficulties benefited from having short vowels in their reading, while children in the second to fourth grade and readers with average reading skill did not. Because all the adapted Arabic tests used single words to reduce ambiguity, all the participants in the current studies read the list of words with diacritic marks.

Words in the Arabic language can be monosyllabic or have two, three, four, five, six or seven syllables. The number of syllables can increase or decrease based on the position of the word in the sentence. When the word concludes a sentence, the final vowel is omitted, but when the word is followed by another word, the final vowel is pronounced, which introduces an additional syllable. The most common convention for finishing a sentence in Arabic (either spoken or written) is to not pronounce the last vowel of the final word in a sentence, but to stop on it. Problems with spelling and reading arise due to the complicated nature of the Arabic language, particularly for beginners or for any reader of non-diacritical texts, which often require individuals to guess words based on syntactic and other contextual details.

2.3.3 Arabic Orthography

Arabic is considered a consonantal 'abjad'. An abjad is a writing structure made up of consonants, and short vowels are not generally written. These writing systems, such as the Arabic language, are almost entirely written from right to left (Thomas, 2020). Arabic is written in a right-to-left direction. Arabic is deemed transparent (shallow) orthography in a vowelised or marked text, as the relationship between the letters (symbols) and their sounds is predictable. The orthography, however, becomes opaque (deep) in un-vowelised text, as short vowels have to be derived from the context. With the removal of short vowels, beginning or poor readers are unable to read fluently because there is so much ambiguity in terms of pronouncing a word's written form. For example, the word zahab/ذهب could be read as 'ذَهَبْ ' (gold) or ' ذَهب '(went) without the diacritic marks. Hence, diacritic marks reduce ambiguity. However, Arabic is highly homographic, which means that words in the Arabic language that sound and are spelled in the same way have different meanings and pronunciations (Abu-Rabia, 2012). The absence of diacritic marks makes words ambiguous (Eltaif, 2019).

Skilled readers need to depend on strategies other than decoding to attain reading accuracy when text is not vowelised. Such strategies include relying on syntactic and semantic contexts. Diacritical marks can have positive and negative effects; mistakes in recognising short vowels may cause incorrect decoding (Abu-Rabia, 1998), whereas reading words with diacritical marks allows accurate word pronunciation (Abu-Rabia, 1997).

Certain features of Arabic orthography in the other Semitic orthography (Hebrew), as stated by Ibrahim et al. (2002), present a high visual load, reducing efficiency. The complexity of visual information that can affect reading words in Arabic, such as the varying shapes of the letters, diacritics marks and characteristics of each letter, demands the reader to depend largely on visual processing (Taha, 2013). Ibrahim et al. (2002) published a study on bilingual (Arabic–Hebrew) students in Grade 10 with one task reciting from memory and the other task reading single letters aloud. They found that they were able to orally list both Arabic and Hebrew alphabets at the same speed but took longer to read Arabic letters. The researchers concluded that the two languages are phonologically similar; thus, the orthographic and visual nuances of the Arabic language were responsible for the variations found. Everatt et al. (2013) also noted that orthographic factors affect word reading accuracy and rate in Arabic. For instance, vowelised texts were read more accurately and resulted in

faster reading than un-vowelised texts in Arabic. Although vowelised script is more visually complex, it is read more quickly.

2.3.4 Summary of Key Differences Between Arabic and English

Arabic differs from English in many ways. As stated above, in Arabic, sounds always correspond to the same letters (Abu-Rabia, 2001; Abu-Rabia, 2002; Fender, 2008). Furthermore, children are often introduced to vowelised and un-vowelised words in reading texts. In English, however, homophones are present. These are words that sound the same but are spelled differently, such as 'reed' and 'read'. These differences make English difficult to read. Opaque orthography also contributes to the challenge of reading English, as the written alphabet does not entirely represent the phonemic structure of spoken language. There are 44 phonemes and 26 letters, with each phoneme corresponding to more than one grapheme (Ehri, Nunes, Willows, et al., 2001).

Unlike English, which is written from left to right, Arabic is written from right to left, which might pose reading difficulties for bilingual children. Arabic has three vowel letters, and three diacritics marks are placed above or below the consonants to change their sounds. The spelling rules vary with syntax, word structure and inflections at the end of words. Nouns, verbs, pronouns and adjectives all differ according to the gender of the object(s) and depending on whether they are singular, dual or plural. Not only do English sounds like p, v, x, ch and g not exist in Arabic, Arabic sounds like Dhad, Sad, Th, Qaf, Gh and Zh are not featured in the English language.

In Arabic, dialectal variation makes reading complicated and greatly affects the process of learning to read, since the majority of words have several dialects. While dialectal variations of the English language exist, such as Estuary English and Cockney or Yorkshire dialects, dialectal variations are much more pronounced in Arabic. The initial version for children who study Arabic is exposure to Spoken Arabic. They have to learn to read and write another version of the language (Standard Arabic) when they start school. This lack of knowledge of the written language and the pronounced gap between Spoken and Standard Arabic makes studying similar to learning a second language (Ayari, 1996). Bilingual children who learn English as a second language, like the participants in the current thesis, need to deal with at least two different forms of Arabic—Standard Arabic and Spoken Arabic—in addition to English. When these bilingual children learn to read, they have to gain experience in several different forms of language (vowelised Arabic, un-vowelised Arabic and English). These

variables, when combined, make learning to read in two languages, one of which is Arabic, a complex task.

In the discussion above, the emphasis is on typical reading development in English and Arabic. However, bilingual children who struggle to learn to read may experience different obstacles in each language. The following section discusses reading difficulties in general and across various languages, with a specific emphasis on reading difficulties in Arabic.

2.4 Developmental Dyslexia

The definition of dyslexia is evolving through phases and is still developing, as the exact cause of the disability remains unclear (Elliott & Grigorenko, 2014). Today, there is a general acceptance that dyslexia can be understood as a continuum and may overlap with other specific learning difficulties (Reid, 2002).

Children with language difficulties at the preschool level are predisposed to experience difficulties in reading (Bishop & Snowling, 2004). Children's early linguistic and motor skills have been shown to be predictors of their reading skills (Gooch et al., 2014). In addition, children with a close relative with dyslexia are at a higher risk of dyslexia, as they are predisposed to difficulties in reading and understanding oral language (e.g. Scarborough, 1990; Snowling et al., 2003). Research suggests that about 40% of school-aged children with developmental coordination disorder, dyslexia and ADHD fit into the neurodevelopmental disorder criterion (Kadesjö et al., 1999; McArthur et al., 2000; Rochelle & Talcott, 2006; Willcutt & Pennington, 2000). The neurodevelopmental disorder criterion includes conditions that start and progress during the developmental period, usually before preschool, with characteristics such as impairments in social or academic functions.

There are many scholars who prefer to use the 'discrepancy definition' of dyslexia (e.g. Hulme and Snowling (1997). The discrepancy definition broadly categorises specific reading disabilities as associated with a discrepancy between intelligence and reading accuracy and fluency (i.e. low literacy skills that are not attributable to generally low cognitive ability) and unrelated to attendance at school, sensory problems or other learning or behavioural problems (Cortazzi & Hunter-Carsch, 2000). Most researchers now agree that IQ should not be used to diagnose dyslexic learners because IQ scores do not correlate with measures of reading ability in struggling readers or in typically achieving readers (Fletcher et al., 2018; Stuebing et al., 2009), and because a child who struggles with reading needs support regardless of their IQ (Elbeheri & Everatt, 2012; Gresham & Vellutino, 2010). However, some scholars have advocated for using the IQ achievement discrepancy model for diagnosis and intervention to

exclude mental retardation and inadequate instruction (Flowers et al., 2001; Machek & Nelson, 2007; O'Donnell & Miller, 2011).

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), which is used to diagnose mental disorders in English, categorises dyslexia as a learning disorder specific to reading and writing that can be mild, moderate or severe (Black & Grant, 2014). The DSM-5 uses the term 'learning disorder specific to reading and writing' to describe a reading disorder. The DSM-5 has specific learning disabilities (SpLD) as a category but does not provide much detail about dyslexia, so a more detailed dyslexia-specific definition is required.

Many alternative definitions of dyslexia are still in use today. A working and operational definition provides a theoretical framework for assessing dyslexia. The British Dyslexia Association (BDA) proposes a broad definition that is just a description and highlights the variety of challenges children with dyslexia may have (Reid, 1998). This definition describes dyslexia as follows:

> A combination of abilities and difficulties which affect the learning process in one or more of reading, spelling and writing. Accompanying weaknesses may be identified in areas of speed of processing, short-term memory, sequencing, auditory and/or visual perception, spoken language and motor skills. It is particularly related to mastering and using written language, which may include alphabetic, numeric and musical notation. (Reid, 2004, p. 2)

The definition used by the Adult Dyslexia Organisation (ADO) can also be helpful to consider.

> Dyslexia may be caused by a combination of phonological, visual and auditory processing deficits. Word retrieval and speed of processing difficulties may also be present. A number of possible underlying biological causes of these cognitive deficits have been identified and it is probable that in any one individual there may be several causes. Although children and adults with dyslexia may experience difficulties in the acquisition of reading, writing and spelling, they can be taught strategies and alternative learning methods to overcome most of these and other difficulties. Every dyslexic person is different and should be treated as an individual. (Reid, 2004, p. 2)

In general terms, dyslexia occurs mainly at the level of the single word and involves the ability to read and spell printed words.

> Dyslexia is evident when accurate and fluent word reading and/or spelling is learnt very incompletely or with great difficulty. The emphasis on 'word level' implies that the problem is substantial and persistent, despite the opportunity to learning at the proper level. It provides the basis for a staged assessment procedure through teaching. (Reason et al., 1999, p. 11)

This definition of dyslexia takes into consideration that those with inadequate learning opportunities may still be struggling and unable to make any adequate progress despite getting the assistance they need (Solity, 1996). These individuals would not be diagnosed as dyslexic.

However, some researchers do not regard dyslexia simply as a literacy difficulty, as some aspects of motor, organisational skills and numeracy may be affected (Department for Education and Skills, 2004). These definitions are also significant in the assessment of dyslexic learners studying a second language, just as they are for monolingual learners. Cortazzi and Hunter-Carsch (2000) added that the dilemma of defining dyslexia 'is challenging enough in relation to monolingual children, but becomes even more complex with reference to assessment of multilingual children' (Cortazzi & Hunter-Carsch, 2000, p. 41). Attempts to distinguish between children with and without dyslexia have been argued to lack scientific and practical validity (Gibbs & Elliott, 2020), due to the absence of a clear differentiation or agreement on the term. According to Elliott and Grigorenko (2014) and Gibbs and Elliott (2020), complex reading difficulties obviously do exist, frequently with a wide range of additional issues, such as attention issues and memory problems. When the word dyslexia is used to characterise only a subgroup of struggling readers, defined on the basis of issues in underlying cognitive processes, it becomes problematic. Hence, clear criteria are needed to draw this distinction (Elliott & Nicolson, 2016; Elliott & Grigorenko, 2014; Gibbs & Elliott, 2020).

Therefore, a reliable working definition is needed to define children with dyslexia in this thesis. Rose (2009) introduced a widely used definition of dyslexia in the United Kingdom, calling it a 'learning difficulty primarily affecting skills involved in accurate and fluent word reading and spelling' (p. 9). Rose (2009 argued that the leading underlying causes of dyslexia are difficulties in phonological processing, verbal memory and verbal processing. This broad definition encompasses most dyslexic difficulties that can be encountered and, most

importantly, it recognises the difficulties that dyslexic children face at school. Defining dyslexia is not straightforward, and it has been shown to be controversial (Elliott & Grigorenko, 2014). The present research utilised Rose's (2009) definition and included all children with decoding difficulties.

2.5 Theories of Developmental Dyslexia

Various theories have been put forward to explore the underlying causes of the slow and inaccurate word reading that characterises developmental dyslexia. This section provides an overview of two cognitive theories of dyslexia that have been highly influential in the field: the phonological deficit hypothesis and the double deficit hypothesis. There are numerous other theories, but this thesis focuses only on these two.

As previously stated, it has been demonstrated that both lexical retrieval skills and alphabetic decoding skills are involved in literacy acquisition, and studies show that in many cases, developmental dyslexia is attributable to language-based reading impairment (Catts, 1989; Lyon, 1995; Snowling, 1998). As the current study focuses on phonological processing skills and reading skills for typically developing children and children with dyslexia, it is important to find the most relevant theory. The researcher is interested in the cognitive level, and the phonological deficit and double deficit theories are the two most prominent at this level.

2.5.1 Phonological Deficit Hypothesis

The phonological deficit hypothesis (PDH; Snowling, 2000), which proposes that poor phonological representations, storage and retrieval of sounds from the memory are a core deficit in dyslexia, is a highly influential theory of dyslexia, supported by numerous experimental studies. It aims to explain why people with dyslexia have difficulties with word reading accuracy and fluency, as well as related difficulties with verbal memory and word repetition. The PDH offers a causal explanation for dyslexia. Snowling (1981) proposed the phonological deficit theory, which states that dyslexics have more difficulty with complicated phonological patterns than non-dyslexics. The ability to pay attention to and alter sounds in words is phonological awareness (Peterson & Pennington, 2012). According to the phonological theory of dyslexia, accurate word recognition requires the ability to create letter–sound correspondences. The essential for phonological awareness allows one to retrieve the pronunciation of letters, as well as letter strings, and therefore enables the reader to read the word. Phonological processing is one of the main characteristics of dyslexia

(Ramus, 2003). Carroll et al. (2016) showed that phonological processing abilities were the strongest predictors of dyslexia in children.

According to the PDH, weak phonological awareness, poor verbal short-term memory, and slow lexical retrieval are the three key components faced by individuals with dyslexia, and they are the core cause of reading difficulties (Ramus & Szenkovits, 2008). These problems can be detected in particular in tasks requiring phonological awareness, phonological memory and slow lexical retrieval. Phonological awareness tasks include counting syllables, blending and phoneme isolation (Ramus, 2004). Dyslexic individuals, with a lack of phonological awareness, have challenges completing tasks such as syllable counts, phoneme deletions, or substitution, and alphabetic coding skills also fail to develop (Ehri et al., 2001). Therefore, due to phonological difficulties in these three areas, dyslexic readers manifest difficulties in situations that require retrieval of letters and sounds, production and discrimination (Ramus, 2004).

Difficulty in the acquisition of reading skills may be explained by a lack of coordination between visual and verbal representations (paired associate learning), leading to poor storage in the memory of words' spellings, therefore interfering with understanding and identifying words and the fluency of reading (Hulme et al., 2007; Vellutino et al., 1995). Although the phonological deficit hypothesis is widely accepted as explaining dyslexia, it has some weaknesses, as it focuses only on reading and spelling among dyslexics and not on broader areas of functioning (McLoughlin & Leather, 2013). Nicolson et al. (2001) argue that dyslexic children have literacy difficulties due to the cerebellum not functioning normally. Because of this atypical functioning, dyslexics have difficulties with automaticity, such as balance and coordination. Stein (2004) suggested that not all children with reading difficulties have deficits in phonological processing (Stein & Walsh, 1997), and stated that dyslexics' phonological, visual and motor deficiencies may be caused by deficits in the visual magnocellular pathway, which leads to significant variations in the retinal structure in dyslexics. Thus, while PDH is a good explanation for most children, it does not explain all the challenges and does not apply to all children.

The strongest demonstration of a causal link between phonological abilities and word reading/dyslexia comes from studies that involve phonological skills training. Goulandris et al. (1998) emphasised the importance of phonological ability training and its impact on children's reading and spelling development, especially when the training emphasises sound–letter mappings (Bradley & Bryant, 1983). Hatcher et al. (1994) findings supported the PDH;

they provided evidence to support the phonological linkage hypothesis (a way of developing reading skills by integrating training in phonological skills with letter–sound instruction) by examining the impact of three interventions on at-risk kindergarten pupils' reading and spelling ability. A total of 138 students were identified as at risk for dyslexia and were then randomly allocated to three groups. The first group received training on letter sounds, the second group received training on phonological awareness, and the third group received training on both letter sounds and phonological awareness. The results showed that combining phonological awareness and letter–sound training improved literacy, rather than phonological awareness or letter–sound teaching alone. Snowling and Hulme (2011) examined the elements that could be used in effective reading interventions. They concluded that phonologically based interventions were successful in improving children's word-level decoding difficulties. Specifically, to reinforce emergent skills, they recommended that children with dyslexia and typically developing children (TDs) should receive explicit instruction in letter sounds, phoneme identification and connecting letters and phonemes by writing and reading texts at the appropriate level.

Although many researchers agree that most dyslexic readers have phonological problems, it is also the case that most agree that the PDH does not explain all cases of dyslexia; indeed, most now agree that a multifactorial model is the most likely to offer the best explanation (Pennington, 2006; van Bergen et al., 2014). Pennington (2006) argued that a complex developmental disorder such as dyslexia is likely to be multifactorial and involve multiple risk factors. A phonological deficit could still be a primary causal factor in such a model, but it would need to be accompanied by other biological or environmental risk factors.

The PDH is the most commonly referenced theory of dyslexia. Although this hypothesis offers an appropriate and consistent definition of dyslexia, there is still debate since not all dyslexics demonstrate problems in phonological processing. The key critique of phonological deficit theory as the cause of dyslexia is inaccurate. The next section addresses the double deficit hypothesis.

2.5.2 Double Deficit Hypothesis

The double deficit hypothesis (DDH) differs from the phonological deficit hypothesis in that it suggests RAN and PA can be separate, independent causes of dyslexia (Bowers & Wolf, 1993; Wolf & Bowers, 1999). Notably, while they would not deny that phonological skills are involved in RAN, DDH proponents claim that the RAN–reading link is not purely due to these phonological processes (Heikkilä, 2015). Wolf and Bowers (1999) proposed

three subtypes of reading disability, caused by (1) a single phonological awareness deficit, (2) a single RAN deficit or (3) a combination of both forms of deficit, phonological awareness and rapid naming, known as the double deficit (DD). The latter is thought to be rarest and to result in the most severe reading difficulty due to the combined effects of phonological and naming speed deficits.

There is evidence to support the double deficit hypothesis (Wolf et al., 2000). First, rapid naming tasks, particularly letter and digit naming tasks, have consistently been shown to account for unique variance in reading fluency beyond that explained by phonological abilities, such as PA (Manis et al., 2000; Wolf et al., 2000). Second, children classified into either single or DD subgroups, based on their speed of naming and phonological awareness tasks, appear to perform poorly on independent reading tests compared to children showing no deficit. The DD groups usually score below the single deficit groups on such measures (Kirby et al., 2003; Wolf et al., 2000). Third, phonological awareness and rapid naming seem to be related to reading subskills in different ways, as mentioned in Sections 2.3.1.1 and 2.3.1.2, with the former being more strongly correlated with accuracy in word identification and letter–sound decoding, and the latter more strongly correlated with the speed of word identification and letter–sound decoding (Manis et al., 2000; Wolf et al., 2000).

There is also evidence that children with impairments in both PA and RAN perform persistently more poorly than other children who have only PA deficiencies, even when matched for their performance in PA. Kirby et al. (2003) investigated the reading development of children from kindergarten to Grade 5, divided into groups based on the DDH in a longitudinal study. They utilised measures of PA, two RAN measures and two tests of general cognitive ability, and letter recognition, pseudoword reading and word reading were compared between the three deficit groups and the no-deficit group. Participants in the no-deficit group performed consistently better, while those in the double deficit group performed consistently poorly. Those with single phonological defects performed poorly at first but improved as they progressed in reading. The participants in the naming deficit group performed poorly throughout and as poorly as those in the double deficit group. According to Kirby et al. (2003), the double deficit group was almost two years behind the no-deficit group and showed no signs of catching up.

Studies to improve rapid naming are rare and have demonstrated inconsistent outcomes. Some research (e.g. Conrad & Levy, 2011; de Jong & Vrielink, 2004; Fugate, 1997) that has focused on improving the speed of letter naming showed no benefits of training on the speed

of reading or on RAN. Fugate (1997) found that letter naming training had a profound effect on the speed at which Grade 1 students named letters, which led to an increase in reading fluency. However, this effect was not significant at follow up five months later. In another study performed by de Jong and Vrielink (2004), there was no difference in performance between children who were trained in letter–sound naming and those who were not trained. Conrad and Levy (2011) observed that only with prior orthographic recognition training was there improvement in letter naming recognition in Grade 1 and Grade 2 students who had slow naming speeds and poor reading skills. There is no compelling evidence that RAN training improves reading in the long term.

To better understand the causal relationship between RAN and reading, an intervention study is necessary. Kirby et al. (2010) showed that focused practice could be more beneficial over longer periods. Vander Stappen et al. (2020) piloted a study to inspect RAN training efficacy utilising both behavioural and brain imagery evidence for an intervention in RAN objects offered to children with dyslexia and evaluated by behavioural and brain measurements. Twenty-one children with dyslexia were compared to 21 typically developing children aged 8–12. Compared with the untrained children, RAN performance and word reading accuracy improved noticeably for the children with dyslexia after the intervention. This improved accuracy in word reading showed that RAN objects were predominantly related to increased arcuate fasciculus FA, the part in the frontal lobe of the brain responsible for understanding language through articulation and speech fluency processes. Furthermore, RAN and reading accuracy improved following RAN training for children with dyslexia.

Vander Stappen and Reybroeck (2018) investigated whether RAN is independent of PA in terms of training competence in PA. They examined the impact on RAN through intervention design and the possibility of developing RAN-object training. Thirty-six French-speaking children in Grade 2 from two Belgian elementary schools were split into two classes and given either PA or RAN object training. For two months, 25-minute classes were held twice a week at school, which involved undertaking either PA or RAN tasks. Multiple experimental tests (PA, RAN, word reading and word spelling) were compared between the two groups before and after the intervention and six months later. The results showed that from pre-test to post-test, children trained in PA progressed in PA without improving in RAN, and children trained in RAN improved in RAN but not in PA, suggesting that PA and RAN are two distinct skills. Second, while PA instruction had no impact on word reading accuracy or speed, it affected the students' spelling errors. After the intervention, children in the PA

group made slightly fewer phonological mistakes than those in the RAN group. The RAN intervention improved word reading efficiency, consistent with correlational studies suggesting that RAN is a good predictor of reading speed, even though the RAN intervention had little effect on word spelling. Finally, they discovered that carefully designed instruction could impact the speed of RAN object naming. The intervention's effectiveness was observed over time (i.e. six months after the intervention), demonstrating that such instruction was useful for reading achievement.

RAN-based interventions may be a novel pedagogical approach to reducing the prevalence of reading difficulties in young children. They may also be helpful instruction for children with RAN deficits and reading fluency difficulties. Based on a child's specific difficulty, the implementation of PA and RAN interventions could provide the possibility of offering an effective targeted intervention to increase reading ability. Vander Stappen and Reybroeck (2018) reported that training on RAN increased children's reading fluency and, in a recent study (Vander Stappen et al., 2020), reading accuracy. Vander Stappen and Reybroeck (2018) analysis supports the DDH, but since the study's primary goal was to compare the training effects of PA and RAN, some of the intervention effects could not be fully grasped due to the lack of a control group. Further, PA and RAN share at least some phonological processes.

To summarise, reading is commonly acknowledged as a dynamic system of cognitive functions supported by various brain regions, creating a unique functional system known as the reading brain (Pugh & McCardle, 2009). There is evidence that most people with dyslexia have one phonological deficit but not all, including phonological deficit, naming deficit and probably visual or auditory deficits (Gabay et al., 2020; Pammer & Vidyasagar, 2005). The double deficit theory hypothesises that there are two essential skills present in the cognitive profile of dyslexics that may be deficient together (double deficit) or individually (single deficit). Children's RAN performance cannot be explained solely by their phonological abilities (Wolf & Bowers, 1999).

It is also possible that a genetic/family factor triggers these deficits (Fisher & DeFries, 2002; Grigorenko et al., 2001). Finding a single cause of dyslexia seems unlikely and relying on one theory therefore seems inadvisable. However, there is evidence that the majority of people with dyslexia have phonological difficulties and that phonological processing underlies word reading. The next section considers dyslexia in different languages.

2.6 Characteristics of Developmental Dyslexia in Different Orthographies

The acquisition of two languages calls for an understanding of the orthographic and phonological systems of each language. It is noteworthy that many children from different language backgrounds show similar phonological deficits (Snowling, 2000; Stanovich & Siegel, 1994). In consistent orthographies, naming speed is a better indicator of reading difficulties than reading accuracy (Brizzolara et al., 2006; Holopainen et al., 2001; Wimmer & Mayringer, 2001). However, in less consistent orthographies, dyslexia manifests in the form of inaccurate reading, despite the fact that fluency issues are also present (Ziegler et al., 2003).

Constantinidou and Stainthorp (2009) measured reading accuracy, speed and phonological awareness in Greek children to identify dyslexia. As expected, the dyslexic group's reading accuracy was lower than that of the chronologically age-matched group and comparable to that of the reading age-matched control group. The dyslexic group's reading speed was slightly slower than the reading age-matched group, who read single words at the same rate as the chronological age-matched group. Children with dyslexia face challenges in achieving reading automaticity. Further, Baluch and Danaye-Tousie (2006) found that dyslexic children in Persian (transparent orthography) read more slowly than typically developing children, even when words were high frequency, and they made more reading errors than the typically developing children. However, in transparent orthographies, whether children with dyslexia read faster than their counterparts in English is unclear. Caravolas et al. (2005), for example, compared the reading fluency of Czech and English children with dyslexia and found that while both groups showed deficits in reading fluency compared to TD groups, they did not differ from one another.

Landerl (1997) measured English- and German-speaking children with dyslexia and discovered that both groups had equal reading speed deficits but varied in accuracy, with German reading being more accurate. Studies have found that learners accustomed to more transparent orthographies have fewer problems with decoding than those who are used to less transparent orthographies, suggesting that dyslexic learners are slower readers in transparent languages (de Jong & van der Leij, 2003; Everett et al., 2004; Goswami, 2000; Ziegler & Goswami, 2005). Since there is a one-to-one correspondence of graphemes and phonemes in transparent orthographies, once they have mastered these, dyslexic students may be able to read accurately. However, when contrasted with their English-speaking peers, dyslexic children who learn consistent orthographies at a young age have fewer problems (Serrano &

Defior, 2008; Wimmer, 1993). Children with dyslexia in English typically have difficulties with word and nonword reading accuracy (Rack et al., 1992). When compared to their English language counterparts, dyslexic children had less severe problems with transparent orthographies, such as Greek, German and Italian (Landerl et al., 1997; Porpodas, 1999).

It is important to know whether the pattern of effects observed in English-speaking dyslexic readers can be generalised to other languages. Comparing German- and English-speaking dyslexic children, Ziegler et al. (2003) constructed word lists that were similar in form and meaning in both languages (using cognates, such as 'box' and 'sport') and nonword lists matched on the number of letters, orthographic regularity and consistency, which were estimated based on neighbourhood size (i.e. the number of other words with the same orthographic rime as the target word). In both languages, cognates were words with the same meaning and similar orthography and phonology. The children's reading accuracy and speed were evaluated. While German children (dyslexic and control groups) appeared to read more rapidly and accurately, overall, the accuracy and speed of nonword and longer-word reading declined equally in both the English and German dyslexic children. These findings indicate impairments in phonological coding abilities, including in more consistent alphabetical orthographies. Even in consistent alphabetic orthographies, children with dyslexia read slowly, not unlike individuals with dyslexia reading inconsistent orthographies, and their patterns of reading performance are very similar. The effects of facilitatory body neighbours on dyslexics and reading-level control were significant. Furthermore, dyslexics demonstrated higher levels of facilitation than chronological age controls. The effect of body neighbours was numerically greater in English than in German. They were greater in nonwords than in words. None of these effects had any interaction with the group. Furthermore, both groups showed a comparable degree of neighbourhood effects; items that had many counterparts were named easily in comparison to those that had few, and reading words and nonwords with many neighbours was more efficient than those with few neighbours.

Comparing English and German dyslexic children with English and German TD children, the English children with dyslexia did not appear to use their understanding of larger orthographic units (e.g. orthographic rimes) to read. Instead, they read serially, regardless of the length of the words. Overall, while the dyslexic children read words slowly in German, they demonstrated low reading accuracy and low reading speed in English. Supporting prior research indicates that the causes and consequences of dyslexia are very similar across

regular and less regular orthographies. The next section focuses on children with dyslexia in Arabic.

2.6.1 Developmental Dyslexia in Arabic-Speaking Children

Arabic speakers who learn English as a second language have to contend with a very different phonological and orthographic system, although there is quite a lot of phonological overlap between Arabic and English. Research on dyslexia in Arabic speakers has drawn attention to the role played by vowels in the accuracy of reading Arabic, as un-vowelled words (i.e. those without diacritical marks) require readers to be aware of phonological features that are not present in the written text (Abu-Rabia, 2001; Abu-Rabia & Sammour, 2013; Elbeheri, 2004; Elbeheri & Everatt, 2007).

As discussed in Section 2.3.1, diglossia affects the reading skills of Arab-speaking children with developmental dyslexia. Schiff and Saiegh-Haddad (2017) examined Spoken Arabic and Standard Arabic vowelled and un-vowelled word reading in native-speaking sixth graders with developmental dyslexia and compared it with that of TD children. They distinguished three age ranges of TD children: the chronological age-matched group, a group from Grade 2 and a group from Grade 4. Since the study tested the accuracy and fluency of word reading in Spoken Arabic and Standard Arabic, a fundamental step was taken to develop word reading tests for both language forms. The effect of diglossia on dyslexics is independent of orthographic transparency, as shown by the fact that reading Standard Arab fluently is a difficult task for children, regardless of whether they are dyslexic, as compared to reading Spoken Arab, which is the language they are familiar with at school onset. The difficulty in reading Standard Arabic does not diminish with grade level or decline with development until Grade 6 (Schiff & Saiegh-Haddad, 2017). Children with DD struggle with phonological decoding, making it difficult for them to use the diacritics mark as an opportunity to enhance reading accuracy. When the performance of TD children was examined in reading vowelled and un-vowelled words in both Standard and Spoken Arabic, it was found that the TD children in Grade 2 read vowelled Standard Arabic and vowelled Spoken Arabic more accurately and fluently than un-vowelled, while those in Grade 4 read un-vowelled Standard Arabic better than vowelled. However, the TD children in Grade 6 read the un-vowelled words in both forms accurately and fluently, showing that at this stage, they did not experience greater difficulty reading Standard Arabic than Spoken Arabic. In contrast, the group of dyslexic children read vowelled, un-vowelled, Standard Arabic and Spoken Arabic much less fluently and accurately than their age-matched controls. Their

reading was comparable to that of the second graders. This suggests that vowelisation does not interfere with reading accuracy in dyslexic children. The introduction of vowelised words, which changes the Arabic writing system into a transparent orthography, does not help children with dyslexia read accurately.

In Arabic, phonological skills are predictors of reading accuracy. Maroun et al. (2019) examined the impact of visual processing on Arabic reading accuracy and fluency among dyslexic and non-dyslexic fourth and sixth graders. They measured the speed and accuracy of reading single words and nonwords (vowelled and un-vowelled) and conducted tests of orthographic processing and visual perceptual skill. The results demonstrated that diacritics for all groups reduced accuracy and recognition. Diacritics impede reading by adding to the visual complexity of printed words. Therefore, regardless of reading ability, visual characteristics of Arabic orthography can result in specific difficulties in reading. However, the difference between the groups was explained by phonological differences. In the reading of nonwords task, the dyslexic children read less accurately and more slowly than the skilled readers. In the visual perception tests, the dyslexic children also had lower scores than the skilled readers. Phonological abilities are a stronger predictor of reading performance for words in Arabic.

Reading performance in Arabic is predicted by phonological abilities. In Arabic-speaking children, Elbeheri and Everatt (2007) measured PA abilities, literacy, nonverbal ability, grapheme discrimination, backward digit span and RAN to determine whether there was a connection between phonological processing and reading. The participants ranged from 9–11 years old. The children were split into two groups based on reading abilities and nonverbal ability tests. They used the discrepancy definition of dyslexia: children with dyslexia and typical readers. The findings revealed that their literacy ability was linked to the level of their phonological processing skills. The non-dyslexic group outperformed the dyslexic group in all measures. It can be concluded that phonological abilities are essential for Arabic children to be able to read. Dyslexia is predicted by phonological processing skills, especially phonological awareness and phonological decoding (Abu-Rabia et al., 2003; Elbeheri & Everatt, 2007; Hamdan & Amayreh, 2007).

Even though some researchers have identified dyslexia in Arabic-speaking communities, there is little empirical literature on the topic (Abu-Rabia, 2007; Layes et al., 2015; Mannai & Everatt, 2005; Saiegh-Haddad, 2005; Gharaibeh, 2021). The aim of research conducted by Layes, Lalonde, Mecheri, et al. (2015) was to differentiate between dyslexic and non-

dyslexic fourth and fifth graders in terms of three reading-related cognitive skills: (a) visual attention, (b) RAN and (c) working memory. Layes, Lalonde, Mecheri, et al. (2015) conducted two studies. Typical readers and readers with dyslexia were given reading tasks, visual attention and RAN tasks in the first study. The results showed that the dyslexic children performed poorly in reading skills, and RAN and visual attention predicted their word reading ability. In their second study, Layes, Lalonde, Mecheri, et al. (2015) investigated the relationship between PA, working memory, word recognition and reading comprehension of both dyslexic and TD students. The results showed considerable differences in reading comprehension scores between the groups. They demonstrated that word recognition, PA and reading comprehension were significantly correlated with working memory in dyslexic groups. There was also a close relationship between word recognition and reading comprehension and between PA and RAN. Regression analysis revealed that PA, RAN, visual attention and working memory predicted literacy performance. Readers with dyslexia showed poorer performance than TD readers on the PA and RAN tests in the first study, indicating support for the DDH. However, the study did not employ standardised tests, which would be beneficial in classifying deficits without requiring a comparison with reading-level controls. Individuals with dyslexia demonstrate persistent difficulties in cognitive-related reading skills, including RAN, verbal working memory, morphological awareness and visual attention.

This review has highlighted the major challenges facing research on dyslexia in different languages. These include the challenges of defining and identifying dyslexia, taking into account how dyslexic children perform in reading tasks in different orthographic systems and addressing the specific needs that relate to dyslexia in the Arabic language.

Having addressed reading difficulties in monolingual dyslexic children, it is also essential to focus on the children who form the foundation of this study: bilingual learners.

2.7 Bilingual Readers

The term ‘bilingualism’ has not been used consistently among researchers and theoreticians. It can be defined as using at least two languages (Valdez & Figueora, 2000), and distinct levels of language ability may be associated with bilingual children’s learning experience (Oller, 2008). Bilingualism is widely used to describe those who speak more than one language at different competence levels (Butler & Hakuta, 2004). Bilingual individuals can learn two languages simultaneously or sequentially (Genesee, 2004; Selinker & Gass, 2008).

Simultaneous bilinguals are exposed to two languages from an early stage as infants, receiving dual input before they are old enough to explicitly understand that their input comes from two linguistic sources (Genesee, 1989; Lanza, 1997; Leopold, 1949). In contrast, a sequential bilingual is an individual who learns a second language after their first language has already begun developing (Padilla & Lindholm, 1984). In both cases, if both languages are strongly supported in the education system, differences in language abilities between simultaneous and sequential bilinguals will decrease by the end of elementary school, although this depends on when sequential bilinguals are exposed to L2 (Oller & Eilers, 2002).

Heritage speakers are usually second-generation immigrants, the children of first-generation immigrants who were raised in a multilingual household, either simultaneously or sequentially. In contrast to heritage speakers who are fluent in the language of the host country, first-generation immigrants are likely to have stronger knowledge of their original language and may or may not have had L1 attrition in some grammatical features (Benmamoun et al., 2013). According to Brehmer and Treffers-Daller (2020), since heritage speakers' mother language is typically exclusively used at home, while the dominant language in society is utilised in all other contexts, they get less information in their heritage language. As a result of the widespread practice of conducting instruction only in the majority language, heritage speakers frequently do not receive any institutional support for the development of their heritage language.

In many parts of the world, children are literate in more than one language and more than one script; these children are known as 'biscriptal bilinguals'. Bilingual education is characterised as two language teaching and the use of those two languages as the medium of instruction for any or all of the school curriculum (Andersson, 1970; Bialystok, 2018; Lotherington, 2004). According to Cummins (1989) and Willig (1985), bilingual education fosters higher achievement than monolingual education and has the overarching potential to improve one's cultural capital through exposure to and mastery of a second language.

The driving force in bilingual education for minority language students in the United States was the creation of a programme for children who, due to a lack of English, were at risk of academic failure through integration into the educational process using their mother tongue (including Spanish in the education of Hispanic children). Programmes in the US were judged on how well Spanish speakers learned English (the majority language), while those in Canada were judged on how well English speakers learned French. The effectiveness

of these programmes was measured by how well children could learn the minority language while retaining proficiency in the majority language (Genesee & Lindholm-Leary, 2008).

It is possible to learn two languages simultaneously or sequentially. Learning occurs simultaneously in education systems in which bilingual education is adopted. In education systems such as Canada's, students learn French before English. There is some transfer that occurs between the two languages, even when they have different writing systems, such as English and Arabic (Koda & Zehler, 2008).

Some studies performed after 1960 indicate that bilingual education has positive outcomes, including better awareness of the arbitrary relationship between words and their referents and superior metalinguistic skills (Malakoff & Hakuta, 1991; Popovikj, 2018). Bialystok (1986) hypothesised that bilingual children had enhanced executive functioning as well as an advantage over monolinguals in their control of the linguistic processing needed for metalinguistic problems. Kaushanskaya and Marian (2009) suggested that bilinguals may be better at acquiring new words because of their previous experience with two languages. Children who are exposed to two phonological systems may develop more tolerance and flexibility, which could contribute to better learning of new phonological information (O'Brien et al., 2019; Sebastián-Gallés et al., 2005).

There are some advantages to being bilingual when it comes to acquiring vocabulary (Salomé et al., 2022). When measuring one language, vocabulary tends to be smaller in bilingual speakers, but when adding both languages and comparing them to a monolingual's single language, it tends to be larger (Gathercole & Thomas, 2009; Hoff et al., 2012). English as an Additional Language (EAL) children in the UK tend to be as good as or better than monolingual children in phonological skills and decoding, depending on their level of English exposure (Goldstein & Bunta, 2012; Kang, 2012; Kovelman et al., 2008; Souza & Leite, 2014).

Diverse perspectives on the advantages and disadvantages of bilingualism have been offered by scholars. Some disadvantages include that bilingual children have been shown to have a lower receptive vocabulary score, even in their dominant language (Bialystok, 2001; Bialystok et al., 2010), and greater difficulty naming objects in pictures (Michael & Gollan, 2005).

With regard to Arab countries, bilingual education has only recently begun in the Gulf States (Kuwait, Oman, Qatar, Bahrain and Saudi Arabia; (Zakharia, 2017). In the 1970s,

formal systems and Ministries of Education were first established, and the discovery of oil was followed by the rapid growth of industry and cities. Only private and international schools have taken advantage of bilingual education in the Gulf region, including the KSA, educating both national and foreign students. In mainstream schools, the main language of teaching is Arabic, and English is taught as a subject. However, Gulf countries attract the most foreign workers and tourists, and expatriates come to fill the employment shortages created by economic growth (Siemund et al., 2021). Globalisation and the movement of Western workers has resulted in an increased demand for English. Thus, most Gulf countries have adapted their education systems; for example, the UAE's educational development goal for 2020 calls for a change in language policy for public schools. The reform programme involves developing English language abilities for elementary pupils starting in Grade 1, with the goal of teaching mathematics and science in English (Zakharia, 2017).

In the Saudi government's strategy for education from 2004 to 2014, the quality and quantity of English teaching was prioritised alongside the advancement of Arabic, since most universities in Saudi Arabia require students to complete basic courses in English as well as bachelor's and master's programmes in English. Consequently, from 2021/2022 onwards, the Ministry of Education changed the English teaching strategy of public schools to start from Grade 1 instead of Grade 4 (Ministry of Education (MOE, 2021). The current research includes various types of bilingual/multilingual children and monolingual Arabic speaking children, such as heritage speakers (born in the UK) and children who acquired two languages (Arabic–English) from birth. The participants in Studies 1 and 2 were all recruited from schools, and they were educated in Arabic and or Arabic-English. However, the degree to which individuals performed better in one language compared to the other varied. Section 3.5 provides further information about the participants.

2.7.1 Exposure to the Language

Language exposure takes place when someone's contact with a language increases, whether they are exposed to it generally or to specific aspects of it (Al Zoubi, 2018). It is often thought that exposure to L2 correlates with L2 achievement, and it is widely believed that the amount of time students spend studying L2 is linked to their L2 learning achievement (Sparks et al., 2012). Time is obviously necessary for L2 learning, and students learn better when they have more exposure (Agirdag & Vanlaar, 2018). Students enrolled in full immersion programmes, for example, reach higher levels of proficiency in the L2 than

students enrolled in partial immersion programmes, according to Canadian studies (Holobow et al., 1987); see also (Cenoz & Genesee, 1998).

Age is one of the most contentious topics in the area of L2 acquisition. The opportunities and interests of the group will affect what a bilingual education programme can start with, and this is likely to vary with age. When it comes to second language learning, it is commonly assumed that 'younger is better' (Birdsong, 1999; Genesee et al., 1978; Harley & Wang, 1997; Long, 1990). However, there is also evidence that older students can make significant strides in studying second languages in education (see Krashen et al., 1979 and Genesee, 1988, for reviews). Other research shows that kindergarten and early elementary school students in Grades 1 and 2 appear to have a better level of English L2 learning than those who begin later, in Grades 4 or 7. Genesee (1981) found that early immersion students who began in kindergarten scored substantially higher on listening, communicating, reading and writing assessments than one year late immersion students (Grade 7). These results suggest that the benefit of late immersion students in two-year programmes is related to both the amount and age of L2 exposure.

According to Clyne (1986) learning a second language earlier gives a child an advantage over their peers when it comes to developing metalinguistic awareness (the ability to conceptualise language as separate from meaning), and it also gives them a better understanding of and familiarity with their first language functions. The metalinguistic awareness he mentions may also be connected to reading skills (Clyne, 1986). This implies that to bring out children's full potential, it should be thought of as an approach to teach second languages in schools. Metalinguistic awareness skills may be strengthened in bilingual children as a result of learning two languages, which may necessitate focusing on the qualities of both languages (Chen et al., 2004; Galambos & Goldin-Meadow, 1990). Students who learn to read in two languages may also have an advantage in understanding the symbolic aspect of sound-to-letter correspondence as their two writing systems correspond to a variety of sounds in both languages in a very complex form (Bialystok et al., 2000). Bilingual development may also help children's cognitive and metalinguistic skills. The following section describes the theories of cross-linguistic transfer skills.

2.7.2 Home Language Environment and Exposure to Second Languages

Bilingual exposure and language usage can differ across people, across languages and with regard to their experiences (Gildersleeve-Neumann et al., 2008; Grosjean, 1998; Hammer et al., 2012; Pearson et al., 1997; Westeren et al., 2018). Bilingual families differ in

the number of family members communicating with the child in each language, the language they use, and home language learning activities that facilitate learning and retaining both languages (Gathercole et al., 2014; Hammer et al., 2012).

According to Huttenlocher (1998), the concept of language input is one of the most critical aspects of bilingualism. Everyone requires language input to learn a second language (Gass, 1997). The greater the input, the better the long-term skills of the language one will acquire. Therefore, input becomes a significant booster for learning a second language if one is living in a community speaking that language (Sivertzen, 2013). Increased input provides more exposure to specific words and language structures (Silva-Corvalán & Treffers-Daller, 2015). Ellis (2002) emphasised that learners should understand that continuous exposure is the best way to learn a language. Also, the length of time that one is exposed to a language has a significant effect on learning it (Graham et al., 2017). The more frequently a learner encounters a structure in a language, the easier it is to identify and generate it.

Another factor that impacts the learning of a new language is input. This includes everything the student hears and sees in the new language. The environment often changes depending on the situation. For example, watching television and participating in classroom activities create different environments. According to Dulay et al. (1982), the quality of the linguistic environment is critical for success in learning a new language. An environment with minimal exposure to the language is not of any benefit to the learner. Dickinson and Tabors (2001) discovered that language use at home (where English was spoken) and language use in the school environment are correlated with reading development in English. The child's environment offers language input for them to process.

Papastefanou et al. (2019) investigated whether language and reading skills in Greek (minority language) and English (majority language) were related to contextual factors such as age, education level and language use at home. They found that the amount of exposure to a language strongly influences performance in that language and that Greek expressive vocabulary was associated with its use both within and outside the household. However, no significant association was discovered for English between the amount of expressive vocabulary and the degree of language exposure. Being competent in English did not require a child's parents to use it at home, as presumably these children were hearing English in their environment at school or with friends. Moreover, using a minority language had no significant effect on children's development of majority language vocabulary and reading skills. In conclusion, encouraging the use of one's native language at home does not hamper

children's ability to communicate in the majority language but is essential for the maintenance of the minority language.

Research has established a cause–effect relationship between exposure and linguistic dominance; the quantity of exposure influences one's preference for a language (Alsahafi, 2019; Yağmur, 2017). Alsahafi (2019) interviewed 10 bilingual Arabic–English-speaking children (9–13 years of age) living in Auckland, New Zealand, to learn about their perspectives on Arabic and English. Despite their poor Arabic abilities and preference for English, nine described Arabic as their first language. The majority confirmed that learning and using English was easier than Arabic in an English-dominant environment. The findings of the study revealed that children's perceptions of the difficulty of learning and using Arabic are consistent with their language skills and preferences for English. In the context of immigrant multilinguals, language has two opposing domains. It is either one's native language (minority) and associated with more intimate environments, such as family, or the majority language is associated with more formal environments, such as education. A lack of Arabic exposure prevents children from learning and using their native language.

According to Silva-Corvalán and Treffers-Daller (2015), even if children learn two languages early in life, they often demonstrate greater ability in one language or a particular feature of the language than monolinguals or other bilingual children who learn the same language pair at an older age. The reasoning is that bilingual children have less exposure to each language than children exposed to only one language (Bialystok et al., 2010). Research on monolingual children supports the relationship between how often children hear words and how easily they are able to develop their language after hearing the words being spoken in their native language, which is aligned with the view that children's exposure to input influences the development of language (Hoff, 2006).

Papadopoulou (2005) argued that learning to read in two languages might result in learning ambiguity and conflict with both reading and linguistic systems during the same developmental period. However, some scholars (Kovács & Mehler, 2009; Krashen, 2005; Oller & Eilers, 2002) found that children who are exposed to two languages are able to easily distinguish between them at an early age and are able to learn both of them over time. Bilingualism tends to offer children more exposure to activities such as language games and enhance their phonological awareness (Bialystok & Herman, 1999). This comes with both increased exposure to oral language and improved knowledge of vocabulary. These factors enhance phonological awareness by raising sensitivity to speech sound units. Therefore,

bilingualism enables children to recognise two separate sets of sounds, allowing them to be more sensitive to the sound units that make up words.

2.7.3 Theories of Cross-Language Transfer

Researchers who have studied bilingualism have developed hypotheses that can be applied to reading. First, the most relevant hypotheses are discussed: the developmental interdependence hypotheses (Jim Cummins, 1979; Cummins, 1981, 2000) and the central processing hypothesis (Geva et al., 1997; Geva & Wang, 2001).

Different theories have been proposed to understand connections between languages in bilinguals based on features of language proficiency or cognitive abilities that are typical in L1 and L2 and that could be transferable between languages. Cummins (1979, 1981) proposed the linguistic interdependence theory, which states that a child's second language competence is partially contingent on their first language proficiency. This theory states that some elements of L1 linguistic information can be effectively transferred to L2 acquisition, thus improving L2 literacy skills. The more evolved the first language is, the more quickly the second language develops. It is more difficult to achieve bilingualism when the first language is in its early stages of development, although that is what simultaneous bilinguals do. The interdependence hypothesis (Cummins, 1978, 1979, 2000) interprets such transfer based on fundamental features in two closely related languages, such as Spanish and English, and more linguistically distant languages, such as English and Chinese. The threshold hypothesis (Cummings, 2001) holds that before learners can benefit from using a second language as a medium of instruction in school, they must attain a minimum degree of skill in that language. This theory postulates that second language skills are developed based on the first language. It indicates that a child with highly developed L1 skills at the beginning of L2 exposure will also acquire high-level skills in the L2. The stronger the L1, the better the acquisition of L2. Learning that has taken place in the L1 can transfer to the L2, but this is not automatic. It depends on how well the student has acquired adequate linguistic skills in the L2 and the quality of teaching for the L1 (Cummins, 2012).

There is much evidence in favour of the interdependence theory (Cummins, 2005). Various studies have shown strong relationships between reading levels in L1 and L2 (Cummins, 1979, 2005; Verhoeven, 1994). Cross-linguistic links between L1 and L2 literacy abilities have been established in previous research (e.g. Bialystok et al., 2005; Comeau et al., 1999; Kruk & Reynolds, 2012; Yang et al., 2017) and orthographic processing (Deacon et al., 2013; Deacon et al., 2009) and decoding (Bialystok, Luk, et al., 2005; Bialystok, McBride-

Chang, et al., 2005; Genesee & Jared, 2008). Despite the significant relationships found in languages that are very similar, there are also significant relationships found between reading methods and languages that have many differences, such as English and Chinese (Yang et al., 2017). This requires further investigation to gain a better understanding of the links across languages and common underlying proficiency (Koda, 2012). To assess the unique skills required for reading development in different languages, precise measurements of specific literacy skills are required.

A study by Geva and Siegel (2000) confirmed the interdependence hypothesis, finding that reading efficiency in the L2 is affected by L1 orthography and that orthographic differences play a crucial role in the process of acquiring L2 reading. Therefore, the challenges faced in literacy may be caused by dissimilarities in orthographic rules between languages. Differences between L1 and L2 orthographic systems affect the development of L2 reading skills. For instance, Arabic-speaking children learning English as their L2 may experience reading and writing challenges due to the two languages' orthographic transparency dissimilarities.

According to the central processing hypothesis, the acquisition of reading skills does not depend on orthography (Gleitman, 1985). It underlines the relevance of cognitive processes, such as phonological abilities, in the establishment of reading skills in the L1 or L2 (Da Fontoura & Siegel, 1995; Durgunoğlu et al., 1993; Geva et al., 1993; Hu & Catts, 1993; Mann, 1986; Näslund & Schneider, 1991). It goes further to hypothesise that those with inadequate cognitive and linguistic abilities will have difficulty regardless of the language and script, and regardless of whether they are using their L1 or L2 (Brown & Hulme, 1992; Doctor & Klein, 1992; Durgunoğlu et al., 1993; Geva & Ryan, 1993; Herringbone, 1992; McLaughlin, 1992; Stevenson et al., 1982).

Geva et al. (1997), Geva and Wang (2001) and Geva (2006) took a universal perspective on literacy acquisition. According to this theory (central processing hypothesis), orthographic features have no effect on a learner's ability to improve reading skills during development. According to its supporters, individual differences in reading competency are defined by the major and universal psychological processes that influence literacy development and phonological processing. Geva (2000) also found that reading abilities in one language (English) were strongly correlated with reading skills in another language (Hebrew).

A different theoretical point of view about the cross-linguistic transfer of literacy abilities is provided by the script-dependent hypothesis (Liberman et al., 1974; Lindgren et al., 1985). The main focus of the script-dependent hypothesis is on taking into account the features of L1 orthography while reading L2 orthography. Reading efficiency in the L2 is a direct effect of L1 orthography, and orthographic variances play an essential role in the L2 reading process (Abu-Rabia et al., 2013). Reading difficulties in a language are associated with the degree of grapheme–phoneme correspondence in that language, according to the script-dependent hypothesis. As a result, children's ability to read in a second language is affected by their ability to read in a first language. The hypothesis also asserts that the development of reading skills in a particular language is constrained by the orthographic characteristics of that language. For example, it may be that poor decoding of a first language reflects a difference in grapheme–phoneme correspondence (e.g. opaque language); nevertheless, poor decoding of a second language with a distinct orthographic system may not relate to this skill (e.g. transparent language; (Katz & Frost, 1992).

According to the script-dependent hypothesis, it is possible for individuals to be dyslexic in one language but not in another due to the visual, phonological and semantic distinctions that exist between languages, each of which places different demands on word recognition systems. (Wydell & Butterworth, 1999) studied a Japanese-English child with dyslexia who learned English as a second language. His performance in Japanese phonological processing skills was better than in English. Moreover, phonological awareness between the two languages was not correlated, and awareness of the Japanese phonology did not help in English. The depth of English orthography and the low correspondence between letters and their sounds represent substantial obstacles.

In addition, some theories suggest that reading development must differ according to the level of orthographic transparency (Bialystok, 2002; Prema, 1998, 2000; Shanbal & Prema, 2007b; Veii & Everatt, 2005; Wang et al., 2003). Some researchers suggest that reading skills are related across languages, whereas others claim that they are not (Durgunoğlu, 2002; Geva & Wang, 2001). Therefore, the cross-language transfer of reading skills must be studied to increase understanding of the differences in reading and reading-related skills between languages.

2.7.4 Cross-Linguistic Skills Transfer

Traditionally, cross-linguistic transfer is defined as the use of linguistic (and cognitive) knowledge acquired in the L1 for L2 learning (Odlin, 1989). Several studies have shown the

transfer of specific literacy skills, including decoding skills, reading-related skills and letter knowledge from L1 to L2 (Dickinson et al., 2004; Goldman et al., 1984; López & Greenfield, 2004; Verhoeven, 1994). Bialystok, Luk, et al. (2005) suggested that bilingual children who learn the concept of grapheme–phoneme correspondences and orthographic patterns in one language can easily apply this ability in another language. Moreover, some studies have shown that transfer can also occur in reverse from L2 to L1 (Altmisdort, 2016; Andreou & Segklia, 2019; Cook & Cook, 2003).

Individuals learning to read in an alphabetic L2 have learned the primary key literacy premise that characters represent sounds in their L1, as well as the ability to map between phonological and orthographic representations. When learning a second language, it is not necessary to relearn this principle (Bassetti, 2013). The transfer facilitation model explains the reading skills transfer process (Koda, 2005). According to this model, as learners' first language literacy abilities improve, they become more automatic in mapping sounds to spellings. The model claims that transfer is predicated on the presence of solid L1 abilities, which are then moulded when confronted by the unique orthographic features of the L2 writing system (Koda, 2005). The model also suggests that metalinguistic awareness abilities in one language can be shared with any other language that requires the application of similar abilities. This occurs even in languages such as English and Chinese, which are linguistically and orthographically different.

Reading subskills established in the L1 have been found to assist L2 reading development, such as decoding in the writing system (Dressler, 2006). As a result, learners' cognitive skills in their first language support and reinforce the development of these skills in other languages. Koda (1994) listed the following factors for explaining differences between L1 and L2 reading: (a) the effect of previous literacy, (b) limited language knowledge and (c) the effect of cross-linguistic transfer. Koda's arguments are essential for two reasons. First, it is necessary to compare the students' reading behaviour in different languages to find their distinctive reading patterns. Second, a thorough investigation of linguistic interchange and the consequences of this interaction on cognitive abilities would make a significant addition to our understanding of how L2 reading differs from native reading.

Several factors, such as the linguistic distance between the two languages, determine the degree of transference between them. For example, Spanish and English share similar alphabetic scripts and linguistic roots. Pasquarella et al. (2015) compared three languages to assess the transference of reading accuracy and reading fluency between them. The

participants were Spanish–English and Chinese–English bilinguals. The correlation between word reading accuracy in English and Spanish indicated structural similarities. Both languages use the Roman alphabet, providing cross-language relationships and enhancing word reading accuracy. Hence, the correlations were higher between English and Spanish than between English and Chinese. However, in Spanish–English bilinguals, the crossover effect of word-reading accuracy was not observed in the opposite direction: Grade 2 Spanish word-reading accuracy was not a predictor of Grade 2 English word-reading accuracy. The children were more proficient in English than Spanish, which may explain this pattern of effects. For the Chinese–English transfer in reading skills, the relationships between Chinese–English reading accuracy were non-significant. Word reading accuracy transfer appears to depend on common structures between the L1 and L2.

Turning from reading accuracy to efficiency, in the same study, bidirectional relationships were identified regarding word reading fluency among Spanish–English bilinguals. In Spanish and English, word reading fluency was similar, even though Spanish is a transparent language and English an opaque one. Importantly, in the Chinese–English bilinguals, the two languages represented by different types of orthographies, a cross-language transfer of word-reading fluency was also observed. Since cross-language relationships existed between the Spanish–English and Chinese–English bilinguals in word-reading fluency, it appears that the underlying mechanism is relatively universal and not heavily affected by variations in L1 and L2 orthographies (Pasquarella et al., 2015). To summarise, cross-linguistic transfer seems to be universal for fluency; however, for accuracy, it is script-specific.

If children can identify their first language's phonological structure, it should be easier for them to transfer their phonological abilities to the second language. Children from an early age begin to recognise the difference between words that vary only by a few phonemes but correspond to entirely different meanings, such as cat and car (Metsala & Walley, 1998). Sensitivity to these distinctions occurs much more quickly in languages with complex morphologies. Arabic pre-schoolers who are beginning to read rely heavily on the correspondence between letters and sounds, as the students would not read as much vowelised texts from Grade three onwards and at age nine, children begin to rely more on other cognitive abilities (Abu-Rabia, 2019). Therefore, phonological skills may attain a deeper relation in older Arabic readers than younger Arabic readers.

In their spoken language, children need to differentiate between similar words. If a word has several neighbours—a large number of similar terms differing by certain phonemes—this

demands that children restructure their phonological representations and pay attention to the finer differences between the words (Durgunoğlu, 2002). Surprisingly, although similar words with a large number of neighbours are more easily manipulated in phonological awareness tasks (Durgunoğlu & Öney, 1999; Goswami, 2000), those words face competition from their neighbours and are more challenging to identify under poor or deteriorated presentation conditions (Garlock et al., 2001). As a result, children can begin to attend to various phonological units depending on a language's characteristics. If bilingual children have some skills in their L1 that can transfer to their L2, they may be more likely to acquire specific proficiencies in their L2 as their L2 proficiency develops.

Children with dyslexia, on the other hand, tend to have a more challenging time reorganising their phonological representations when they encounter a second language, particularly if their language lacks a transparent orthography with clear correspondences between phonemes and graphemes (Goswami, 2000; Metsala, 1997; Wimmer et al., 2000). Abu-Rabia et al. (2013) studied cognitive retroactive transfer in bilingual students with learning difficulties who were transferring linguistic skills from L2 (English) to L1 (Arabic). The experimental group's intervention targeted L2, but it also improved L1 writing and reading skills, except for Arabic spelling. Another relevant study by Abu-Rabia and Shakkour (2014) examined whether improving the linguistic skills of multilingual students with poor reading skills in English (L3) would help them develop both their L2 (Hebrew) and their L1 (Arabic). The instructor chose students in Grade 6 who were weak in Arabic, Hebrew and English. The children were split into two groups. The experimental and control groups were given a series of tests to measure orthographic competence, phonological awareness, morphological awareness, syntactic awareness, reading accuracy and reading comprehension in English, Arabic and Hebrew. Before and after the trial, the experimental group received the intervention (which aimed to improve orthographic, phonological, morphological, syntactical, reading and reading comprehension skills) in English only. Following the intervention, the children showed significant improvement in linguistic and metalinguistic skills in all three languages. The only exception was in orthographic skills in Arabic and Hebrew. Improving children's performance in one language can lead to improvements in their other languages, particularly in alphabetic languages (Pasquarella et al., 2015).

To summarise, the studies examined here have shown that PA is essential for bilingual children and that PA predicts the reading skills of bilingual children learning to read in L1

and L2. Therefore, PA is considered a common element compatible with the theory of linguistic interdependence across alphabetical languages. The ability to transfer reading skills from one language to another depends on the presence of common language structures between the two languages. The current study is concerned with understanding the mechanisms described in the introduction of this thesis, as children who are bilingual learn mainly in two different contexts of language systems, such as Arabic and English.

2.8 Conclusion

This chapter provided an overview of typical and atypical reading development, with a particular focus on word-reading skills. It discussed phonological processing, concluding that RAN is a predictor of reading efficiency and PA is a predictor of reading accuracy. After addressing the definition of dyslexia, the phonological deficit and double deficit theories were discussed as accounting for core cognitive deficits in children with reading difficulties (RD). Upon considering the reading development of monolingual children with reading difficulties, the chapter introduced bilingual learners, the importance of phonological skills in a second language and the effects of bilingualism on children with reading difficulties. The need to conduct further research on reading difficulties in the Arabic language was highlighted, along with the specific features of the Arabic language that may be particularly challenging for children with reading difficulties.

2.9 The Present Studies

The literature review indicated that only a few studies on Arabic–English bilingual speakers have examined the transfer of PA, RAN and PM skills from L1 to L2 and the influence of phonological processing skills on reading acquisition. This thesis used samples with Arabic as the L1 and English as the L2.

A few previous studies have clarified the relationship between phonological processing skills and dyslexia in Arabic; for example, Elbeheri and Everatt (2007) and Layes et al. (2014). No studies have focused on the transfer of skills from L1 to L2 in combination with the identification of Arabic–English bilingual RD children. This indicates a need for a deeper understanding of phonological processing and its effects on reading skills in bilingual children in general and bilingual children with reading difficulties in particular. Consequently, many questions in the area of phonological processing and its association with the reading skills of Arabic–English children remain unanswered, such as those related to differences in reading performance in Arabic–English bilingual children between their two languages. To address these questions, the main objective of the current study was to explore

the relationship between phonological processing and reading skills, beginning with typically developing bilingual children and then moving to those who have reading difficulties but have not been diagnosed with standardised assessment tools. Due to the lack of standardised assessment in the KSA, there are difficulties in identifying, assessing and being aware of learning difficulties among primary school students (Alquraini, 2011). Taibah et al. (2011) designed a standardised test of phonological processing for children in Arabic in Saudi Arabia; the researcher contacted the King Salman Disability Research Centre but was not given access to use the test.

To address these questions, the main objective of this thesis is examined first with bilingual Arabic–English children, by comparing reading and reading-related skills in English and Arabic and then comparing them with Arabic monolingual children to see whether the relatively poor performance in Arabic compared to English in the biliterate participants was due to a lack of exposure to Arabic or to the quality of the education system in Saudi Arabia. This was done by comparing the Arabic reading and phonological processing skills of monolingual Arabic speakers with biliterate children in Arabic. In addition, PA, PM and RAN were measured to examine whether they predicted reading accuracy and efficiency in monolingual Arabic children.

Finally, Study 2 included bilingual Arabic–English children with reading difficulties who were chosen by their teachers based on their poor performances in reading and spelling, as there is a lack of standardised assessments for bilingual children in Arabic and English. The pattern of reading accuracy, reading efficiency and phonological processing skills in this group of children was compared to that of the typically developing biliterate children from Study 1. The research questions were formulated as shown below.

2.10 Research Questions

2.10.1 Study 1

- Are there differences between Arabic and English in reading (accuracy and efficiency) and phonological processing (PA, PM and RAN) in biliterate Arabic–English children?
- Do biliterate and monolingual Arabic children differ in measures of Arabic reading accuracy and efficiency and in phonological skills (PA, PM and RAN)?
- Which aspects of phonological processing are most strongly predictive of reading efficiency and reading accuracy?

Post-hoc question: Did the effect of language (English vs. Arabic) differ according to whether children were living in the KSA or the UK?

2.10.2 Study 2

- How do reading and reading-related skills differ between biliterate children with reading difficulties and typically developing bilingual children?

The methodology used to answer these questions is presented in the next chapter.

Chapter 3 Methodology

3.1 Introduction

The purpose of this chapter is to introduce the method chosen for all three studies and to elaborate on the methodological steps taken in the research process. It presents the study design, study context, materials used and creation and piloting of the testing materials, as well as the ethical considerations of the research. Methodological details specific to each study, including the sampling procedure and participants, are not presented here but in their own chapters.

3.2 Research Paradigm

This section provides a brief background to the choice of research paradigm that underlies the proposed study. A paradigm is described by Mackenzie and Knipe (2006) as a loose set of principles, ideas, theories or concepts that serve as the framework for an investigation that orients thinking and research (Mackenzie & Knipe, 2006). Each paradigm (qualitative and quantitative) has its own interpretation of the world (MacNaughton et al., 2007). Quantitative and qualitative research methods involve very different statements about the role of the researcher and how the research should be conducted. The following subsections describe the characteristics of these paradigms.

3.2.1 Qualitative Paradigm

Creswell described the qualitative paradigm as research that is 'guided by concepts from the interpretive paradigm', stating that it is 'a means for exploring and understanding the meaning individuals or groups ascribe to social or human problems' (Creswell, 2009). Research based on the qualitative paradigm aims to investigate the social reality experienced by individuals, groups and cultures, and its purpose is to explore the behaviour, perspectives, experiences and feelings of people. The main areas for qualitative research are ethnographers, who denote cultural customs; grounded theorists, who inspect social practices and interactions; and phenomenologists, who describe the world and consider the meaning of the experiences within it. Qualitative research is based on the interpretative method of social genuineness and the representations of lived experiences of human beings (Atkinson et al., 2001).

3.2.2 Quantitative Paradigm

Muijs (2011) identified the quantitative paradigm as an approach that explains phenomena by gathering numerical data and assessing them using mathematical methods. The quantitative approach is based on scientific, logical positivism. Positivism is derived from the

natural sciences, as it is based on the knowledge that appears through hypothesis testing; hence, the hypothesis can be assessed by social realities and the results based on experience (Eriksson & Kovalainen, 2008), which requires a deductive approach. It tests specific hypotheses with a narrow lens (Koul, 2009). The aim of this approach is to generate descriptive explanations and predictions of social phenomena. A quantitative approach is most appropriate when the research study uses methods such as descriptive surveys, correlational research, comparative research and experimental research. Since this research involves standardised assessments to measure reading skills and phonological processing for large samples of students and generates specific testable hypotheses, a quantitative approach is most appropriate. A qualitative approach is less suitable because the study is primarily based on hypothesis testing within a positivist framework. Having stated that the area of interest is reading-related skills for Arabic–English bilingual children, monolingual Arabic children and identifying bilingual dyslexia in different languages (English and Arabic), the next step is to describe the research design to determine what methods would best answer the research questions presented in Section 2. 13.

3.3 Research Design

As described by Yin (1994), all research must be designed to link the data collected and the conclusions drawn to the initial research questions. How a research design is chosen depends upon the nature of the research problem being investigated and social science researchers' and scientists' experiences as well as the audience in the study (Creswell, 1994). Research serves as a tool to ensure that the evidence obtained can answer the initial question as unambiguously as possible. The research design emphasises the research logic, such as what evidence is required to adequately address the question (Yin, 1989). Careful consideration of research design issues is vital from the start; otherwise, it is likely that the conclusions drawn will be weak and unconvincing and will fail to answer the research question. The research design for this thesis compares different groups of participants or performance on different tasks by the same participants, using standardised tests of reading and reading-related skills in English, alongside adapted tests in Arabic and a bespoke home languages questionnaire. The design allows the comparison of scores of different groups of participants taking those tests and of different versions (English versus Arabic) of those tests using statistical methods. The next section presents the study context.

3.4 Study Context

This study was carried out in a number of (Arabic–English) bilingual primary schools, as well as in two Arabic schools. They were all private schools in the UK and Saudi Arabia, including one international school in the UK, one Saturday school in the UK, four international schools in Saudi Arabia (mixed-gender bilingual schools in the KSA) and two Arabic-only schools in the KSA. Two of the participating schools, A and B, were located in London. The schools in Saudi Arabia (covering Schools C–F) and School A in the UK were international schools authorised by the Saudi Ministry of Education; all the schools had special education facilities except Schools B, G and H.

The monolingual (Arabic) schools, G and H, were private schools and did not have special education facilities. School G had female students only and School H had male students only (see Table 3.1). All the selected schools had students of different nationalities, but they were all from nations in the Middle East with Arabic as their first language, although the students spoke different dialects of Spoken Arabic, teachers at the schools where the researcher collected data spoke to students using only Standard Arabic. The culture in the Arab world differs from one country to another, but there is common ground in terms of the Standard Arabic language used in education, especially to assist in reading the Quran and to communicate efficiently with other Arabic-speaking people with different spoken dialects. Spoken Arabic dialects differ greatly from one region to another; Standard Arabic does not.

3.4.1 Differences Between International and Private Education in Saudi Arabia

In an international school, a curriculum is offered for preschool, primary or secondary school students, wholly or partly in English, or in the school's primary chosen language, outside an English-speaking country. English-language international schools offer a curriculum in English that is different from the nation's national curriculum and is globally oriented. Some international schools are owned by foreign national organisations in Saudi Arabia, while others are Saudi-owned private schools. At all the international schools in the UK and the KSA in this study, all students studied English on a daily basis. They communicated in both languages (English and Arabic) at school, using about 75% English and 25% Arabic in most classes. All international schools provided bilingual-based international education for students aged 3-18 years (International Baccalaureate Programme).

In Saudi Arabia, the majority of schools are separated by gender. The separation of male and female learners into separate campuses is not essential for international schools. For Study 2, only the private schools in the KSA, G and H, split the genders.

Private Arabic schools in Saudi Arabia (79 participants) enforce and adhere to the Ministry of Education regulations. They provide, along with general studies and science, religious studies and Arabic culture, mathematics, history, Islamic education, arts, geography, science and the Arabic language; these subjects consist of 135 minutes per week of instruction. Extracurricular subjects include computer science and English language teaching, which are very limited compared to the Arabic being taught.

Both private and international schools offer good education. However, what sets their programmes apart is the curriculum they provide. While most private schools follow the standard Saudi curriculum, many international schools provide their own curricula, which often adhere to the international curriculum. Many international schools have made English language communication a requirement, although most private schools focus on their local languages (Arabic; Ministry of Education, 2021).

In the UK, there is an option for children aged 5–16 to attend Arabic and Islamic studies schools on Saturdays. During the week, these students attend mainstream schools that use the English curriculum. These ‘Saturday’ schools include students of different nationalities; for the majority of students, Arabic is their first language, while for others, English or other languages could be their first. Saturday schools provide a balance for students. They attend all English schools throughout the week, since that is the language they use most in the community, but by attending Saturday school, they gain the ability to develop their Arabic language, since some of them are using it at home.

Overall, children who attended different schools varied in their experience of being taught in Arabic. The average school day for children in primary school across all schools was about 6–7 hours per day, with 45 minutes for each lesson. The children who attended Saturday school (B, 29 participants) were taught Arabic for five hours per week. The bilingual children who attended international school (A, 12 children, C, 43 children, D, 7 children, E, 8 children, and F, 5 children) were taught Arabic for 8 hours per week, whereas the children in private Arabic schools (G and H, 78 participants) had about 23 hours per week of being taught the Arabic language in school. Therefore, the children in private schools in the KSA had more exposure to Arabic than the other groups, while the children in the international

schools were exposed to Arabic slightly more than those who attended Saturday school in the UK. Outside school, children in the KSA had more exposure to the Arabic language than those in the UK. In short, children in different schools had considerably different amounts of exposure to Arabic.

3.5 Participants

Participants were recruited separately for all three studies. All the participants were children attending one of these school types described above, and all were between 8 and 12 years old. Of the 76 bilingual children in Study 1, 19 were born in the UK, while the remaining 57 were born in different countries: 28 in the KSA, 14 in Libya, 2 in Kuwait, 5 in the USA, 3 in Egypt, 2 in Oman and 3 in Qatar. Of the 78 monolingual children, 75 were born in the KSA and 3 in Syria. Of the children in Study 2, 2 out of 28 were born in the USA.

All the children who participated in Studies 1 and 2 described Arabic as their first language according to the Home Languages Questionnaire (more detail about the Home Languages Questionnaire can be found in Section 3.6) questions 1, 2, 3 and 4 (see Appendix 3), and all the bilingual children had studied formal literacy in English and Arabic for at least two years.

Children from Study 1 (see Table 3.1) were typically developing children and did not have any known learning difficulties. In Study 2 (see Table 3.1), 28 children who had been identified by SEN teachers as having specific learning difficulties were recruited from an international school in the KSA. The children, referred by the SEN teacher, were invited to take part in the study. Children with other learning disabilities, such as intellectual disability, autism or ADHD, were excluded from this study; more details about the participants for Study 2 can be found in Section 5.2.1.

The selection criteria included children who had completed at least two years of English and Arabic schooling, as confirmed through the Home Languages Questionnaire, to ensure that they were receiving education in the two languages. As indicated in Section 3.4.1, all participants in the study received formal literacy instruction in English and Arabic, but the quantity of exposure to formal literacy instruction in Arabic varied between the international and private schools. Teachers were instructed to select all of the children in Grades 3, 4, 5 and 6. All parents of children in these grades were given a consent form to participate in the study. Of the 60 children in School A, 12 parents agreed to let their children participate. Since the academic year was drawing to a close and the pupils were preparing for exams,

most parents preferred their children not to participate. In School B, 29 out of 34 students participated, and in School C, 35 out of 80 students from Grades 3-6 participated. This indicates that the sample used in this thesis was an unrepresentative sample. School C has 8 students with a specific learning difficulty, school D has 7 students with a specific learning difficulty, and school E has 8 students with a specific learning difficulty; therefore, all the students with specific learning difficulties identified by SEN teachers participated in Study 2. For the private school G, 43 children in Grades 3-6 out of 72 participated, whereas for the private school H, 35 children out of 72 participated.

All Study 1 and 2 participants had formal education in two languages: Arabic and English. All participating children were required to complete a questionnaire to ensure that they were bi/multilingual and to determine their exposure to each of their languages at home and at school (more details about the HLQ can be found in Section 3.6). The tools of data collection used in this study are also discussed in the next section.

Table 3.1

Brief Description of the Studies' Samples

School	School Type	Country	No. of Children	Gender	Study
A	International	UK	12	Mixed	Study 1
B	Saturday	UK	29	Mixed	Study 1
C	International	KSA	35	Mixed	Study 1
			8		Study 2
D	International	KSA	7	Mixed	Study 2
E	International	KSA	8	Mixed	Study 2
F	International	KSA	5	Mixed	Study 2
G	Private	KSA	43	Girls	Study 1
H	Private	KSA	35	Boys	Study 1

3.6 Student Home Languages Questionnaire

Using questionnaires to estimate the use of and exposure to different languages at home can help determine a child's balance of exposure to different languages and which languages they use in different situations (Figuero & Váldezès, 1994). There is no single optimal questionnaire design that is appropriate for all research purposes (Malhotra, 2006). The procedure begins by defining the required data. This thesis uses a Home Languages

Questionnaire (HLQ) created specifically for this study. The researcher had limited time to interview participants, approximately five minutes for each child, because their reading and phonological assessments took approximately 50–55 minutes. For this reason, established questionnaires (such as Q-BEX and Unsworth's UBILEC) were not used. A more comprehensive questionnaire will be considered for future studies to better identify bilinguals and biliterates. The first four questions were mainly concerned with obtaining information about the child's linguistic background. Questions 5 and 6 enquired about language exposure. In future research, established questionnaires could be employed to extract additional information about the multilingual children.

The questionnaire for the present study was designed to be a useful tool for measuring participants' language experience, taking into account a wide range of factors, such as the number of languages spoken, age of L2 language acquisition and situations in which the children hear and use their languages.

An orally administered questionnaire with six items (see Appendix 3) was used to capture L2 learners' language exposure and consisted of closed-ended statements. Questions 1-4 (see Table 3.2) asked the participants to provide information about the languages they spoke to include or exclude them for Studies 1 and 2.

The first question asked: How many languages do you speak? If the child responded with a single language, they would be excluded. However, 73.5% of children in Study 1 and 82% of children in Study 2 reported speaking two languages. 23.5% children from Study 1 and 18% of children from Study 2 responded that they spoke three languages; these children knew French or Spanish as their third language but did not speak it fluently. The second question was: Which language did you learn to speak first? If a child stated a language other than English or Arabic, they would be excluded from the study, although all of them stated Arabic first.

The third question was: What do you consider to be your first language? as this question is similar to the preceding one, the child's response was expected to be identical to the previous question for selection purposes and to ensure consistency and reliability. It is assumed that dominance in one language does not indicate whether it is someone's first language, but rather the language they use more efficiently. Some bilingual speakers are more dominant in one language over the other; the language they are more dominant in might not necessarily be their first language, therefore, by asking this question it would indicate whether the child's

definition of first language is based on the language they learnt first or the language they are dominant in.

Table 3.2

Results of Home Languages Questionnaire of Studies 1 & 2 for Questions 1, 2, 3 & 4

Question	Study 1 (76 children)	Study 2 (28 children)
How many languages do you speak?	73.5% said 2 23.5% said 3 3% said 4	82% said 2 18% said 3
Which language did you learn to speak first?	100% said Arabic	100% said Arabic
What do you consider to be your first language?	100% said Arabic	100% said Arabic
How many languages do you speak at home?	97% said 2 3% said 3	100% said 2

Questions 5 and 6 were Likert scale questions with five responses (Never, Rarely, Sometimes, Most of the time, All of the time) and questions about the proportion of time they spent using English in daily activities, such as having dinner with family and talking to their friends during breaks or outside of school. More detail about questions 5 and 6 can be found in the Study 1 and Study 2 results sections. The HLQ was not administered to monolingual children. In a future study, such a questionnaire could be used with monolingual Arabic students to ensure that they are monolingual.

The questionnaire was administered orally to all children, which took approximately five minutes per child. The questionnaire was in English or Arabic, as chosen by the child, who was asked which language they were more comfortable speaking. If they selected Arabic, the questionnaire was administered in Standard Arabic.

3.7 Measures

As the main aim of the research was to examine reading and reading-related skills in bilingual/multilingual Arabic–English children, it was important to find tests for phonological processing skills, reading efficiency and reading accuracy that could be adapted for use in both languages. Therefore, standardised tests were chosen based on commonly used and

robust assessments cited in the field. All the tests selected were designed for native English speakers. The English assessment measures that were used in this study were norm referenced, whereas the Arabic assessment measures were not standardised. Because it was difficult to find standardised reading and phonological processing tests for Arabic native speakers, the researcher needed to adapt the English tests into Arabic.

Administering standardised tests intended for monolingual speakers to bilingual children can be problematic. When assessing a child's performance on any normed language measure, not only does the child's performance represent their knowledge of the particular language tested, it also indicates whether they have a language disability or a problem with language. However, when a test normed on monolingual children is utilised with bilingual children, the results are not indicative of whether the child is tested in only one of their languages (Pearson et al., 1995). It is unfair to administer a test to a bilingual child in just one language because the possibility of unequal distribution of language exposure and expertise must be considered. Because bilinguals tend to have smaller vocabularies in each language, tests created for monolinguals may not be suitable for bilinguals/multilinguals.

In the current studies the teachers were using curriculum-based measurement to assess the children in their reading skills, which they themselves had developed. The researcher did not use their measurement, as they were in different schools, and therefore not comparable. In addition, different teaching strategies may have affected the children's progress and performance in the assessments. At the time when the studies were conducted, there were no validated measures of reading accuracy and reading efficiency in Arabic. Therefore, it was necessary to construct authentic Arabic reading tasks. It was therefore preferable to adapt the reading and phonological processing tests to assess the participants in the current study. The researcher was unable to create better Arabic tests, establish appropriate norms for them, and standardise them because there was insufficient time to test the large number of children required.

The standardised tests used in this study were the Test of Word Reading Efficiency (TOWRE-2; Torgesen et al., 2012) ,which tests word and nonword reading fluency; the Diagnostic Test of Word Reading Processes (DTWRP; Forum for Research in Language and Literacy, 2012), which tests word-level reading accuracy; and the Comprehensive Test of Phonological Processing (CTOPP-2; Wagner et al., 2013), which tests phonological processing (PA, PM and RAN). These tests are in English, so it was necessary to adapt them

for use in Arabic (see Table 3.3). Each test is described below and the steps taken to adapt the tests are described.

3.7.1 Standardised Tests

Table 3.3 provides an overview of the standardised assessments used in English and the adapted tests into Arabic (more details about the Arabic adapted tests are given in Sections 3.6.4, 3.6.5 and 3.6.6). The key skills that were measured were reading accuracy, reading efficiency and phonological processing skills. These elements of reading skills should be included in any assessment aimed at identifying word reading difficulties (Murray, 2016).

Table 3.3

Brief Description of Instruments Used

Instruments in English	Variables to Measure	Duration
Test of Word Reading Efficiency (TOWRE-2)	Reading efficiency	5 mins
Diagnostic Test of Word Reading Processes (DTWRP)	Reading accuracy	10–15 mins
Comprehensive Test of Phonological Processing (CTOPP-2)	PA, PM and RAN	35 mins
Home Languages Questionnaire	Language experience	5 mins

3.7.2 Details of Individual Tests

3.7.2.1 Test of Word Reading Efficiency (TOWRE-2).

To measure word reading fluency, the Test of Word Reading Efficiency (TOWRE-2; Torgesen et al., 2012) was used. This test measures a child's ability to read real and nonsense words aloud in a list format with accuracy and fluency. It contains two subtests: sight word efficiency and phonemic decoding efficiency. The subtests have vertical lists of words or nonwords and the child has 45 seconds to read each list. The child's score is the total number of words/nonwords read correctly in the 45-second time limit. Sight word efficiency incorporates 108 real words, while phonemic decoding efficiency contains 66 nonwords.

The TOWRE-2 provides a measure of word reading efficiency. This is an important assessment to include, as reading fluency is an important outcome measure in all three

studies. A measure of reading efficiency was also important because slow reading is the hallmark of dyslexia in consistent orthographies.

The TOWRE-2 can be used for individuals aged 6–24 years, and it takes about five minutes to administer. If the participants come to an item that they find difficult to read, they can move on to the next word. Each subtest contains practice items to allow the participants to familiarise themselves with the task.

To determine concurrent validity at three grade levels, the TOWRE was compared by the test developers to the Woodcock Reading Mastery Test-Revised (WRMT-R; Woodcock, 1987). Correlation coefficients ranged from .89 to .94. Coefficients ranged from .47 to .87 for Gray Oral Reading tests (GORT-3; Wiederholt & Bryant, 1992) and TOWRE phonemic decoding efficiency, and for WRMT-R comprehension and TOWRE sight word efficiency for Grades 4 and 5. Regarding the validity of the TOWRE-2, the manuals provide a detailed description of content-description validity, criterion-prediction validity, and construct-identification validity.

Test–retest reliabilities were calculated using 108 participants for different ages: 6–9 years, 10–18 years and 19–24 years. After two weeks, the average coefficients for each testing and standard scores were presented using means and standard deviations. The values of *r* ranged from .82 (for 19 years) to .97 (for 6–9 years), with the majority (17 of 24) being at or above .90. These data are evidence that the test–retest reliability is supported. This was done as part of the development of the tests.

3.7.2.2 Diagnostic Test of Word Reading Processes (DTWRP).

The DTWRP (Forum for Research in Language and Literacy, 2012) can be used with children between 5 years, 0 months and 12 years, 11 months of age, and can be used to measure children's reading accuracy across the three word types: nonwords (e.g. wup), exception words (e.g. know) and regular words (e.g. well). In the current studies, the researcher excluded the exception words subtest; it was difficult to construct Arabic words equal to English exception words because Arabic does not have exception words.

In this test, the child is asked to read 30 regular words and 30 nonwords aloud. As it is not timed, it is a measure of accuracy, not efficiency. While nonword reading, according to the test developers, is the purest measure of decoding, exception word reading is the purest measure of lexical-semantic knowledge. The child's profile of relative strengths and weaknesses in phonological recoding and lexical processes is identified from the score

obtained. The test usually takes 10–15 minutes, introducing nonword reading, exception word reading and regular word reading, in this order. Testing is discontinued for each list if the child makes five consecutive reading errors.

A high degree of test score reliability shows that the results are consistent. The reliability estimates for the whole test (90 items) and for each component subtest (30 items) were calculated using Cronbach's alpha. The Cronbach's alpha for the nonword reading was .96 and .97 for regular words. These reliability estimates are very high. The DTWRP's validity is supported by its extremely high correlations with other reading tests, such as the Single Word Reading Test (SWRT; Foster, 2007) and the York Assessment of Reading for Comprehension (YARC; Snowling et al., 2009) reading accuracy and early word recognition.

3.7.2.3 Comprehensive Test of Phonological Processing (CTOPP-2).

The CTOPP-2 (Wagner et al., 2013) has been standardised for use with people aged 4-24 years old, and the core subtests require around 30 minutes to be administered. The test purports to measure the phonological skills underlying reading and spelling, which can help identify the reasons a child has difficulty reading by identifying any weaknesses in key abilities known to be implicated in learning to read. The CTOPP-2 was designed to measure three areas of phonological processing: the phonological awareness composite score comprises the standard scores of five subtests, the phonological memory composite score comprises the standard scores of two subtests and the RAN comprises the standard scores of two subtests (see Table 3.4).

Table 3.4

CTOPP-2 Tests of PA, PWM and RAN Skills

Phonological Awareness	Phonological Memory	Rapid Naming
Elision	Memory for digits	Rapid digit naming
Blending words	Nonword repetition	Rapid letter naming
Phoneme isolation		
Blending nonwords		
Segmenting nonwords		

In the elision subtest, the child needs to remove initial, middle or final syllables and phonemes from words; an example of phoneme deletion is say 'bold', without the 'b'. The subtest consists of 34 items. In the blending words subtest, the child needs to blend sounds

together to form a word, for example, ‘s-u-n; put these sounds together and make a word’. It contains 33 items. In the phoneme isolation subtest, the child needs to recognise specific phonemes in individual sounds. There are 32 items. In the first 16 words, the child needs to identify the first, middle or last sound; for example, the word frog has four sounds, f/r/o/g; what is the second sound? The next 16 words contain more than three sounds and the child needs to recognise the second, third or fourth sound; for example, what is the second sound in the word island? The blending nonwords subtest is similar to the blending words subtest, but this one contains made-up words; for example, ‘What made-up word do these sounds make? N.i.m.b.y’. The subtest contains 30 items. The most difficult items require the child to blend sounds for more letters, such as ‘b-ou-k-i-n-oo-d-er-l’. In the segmenting nonwords subtest, the child hears a made-up word and is asked to break it down into its individual phonemes; for example, with the made-up word ‘dra’, the child needs to say the sounds they heard, the correct answer being ‘d-r-a’. The subtest contains 31 items.

The subtests of the CTOPP measuring PM are memory for digits and nonword repetition. In the memory for digits subtest, a forward digit span task, the child needs to repeat a set of numbers heard on a recording in the same sequence. The strings of digits range in length from two to eight. There were 28 sets of digits. For the nonword repetition subtest, the child needs to listen to recordings of made-up words and then repeat them back as they hear them; the nonwords range in length from 3 to 15 sounds, such as ‘teeg’. The subtest contains 30 items.

The RAN for digits and letters subtests test the child’s ability to name sets of digits or letters quickly; not objects, as the objects are for children aged 2–5 and all participants in the current study were between the ages of 8 and 12. In both subtests, RAN digits and RAN letters, the child needs to name 36 digits/letters consisting of nine columns and four rows going from left to right. The score is the number of seconds it takes to name all the numbers/letters. Before the child starts the actual test, they have a practice page. If a child is unable to name all of the numbers/letters correctly or makes more than five errors, testing is ended. If the child skips a number/letter or gives it an erroneous name, the items are marked as incorrect. 'Incorrect' answers are marked as 0. However, all children were able to respond correctly to all items.

The scoring for the phonological awareness and phonological memory subtests consists of 1 for a correct answer and 0 for an incorrect or non-response, with a total score for each

subtest. In each subtest, 2–3 examples of questions and answers are presented to make sure the participants understand the task.

Internal consistency and test–retest reliability are important data for CTOPP-2 reliability. For all the subtests except nonword repetition, the average internal coefficients for the composites for CTOPP-2 surpassed the minimum of the .80, with an average alpha of .77 for the nonword repetition subtest. As stated in the manual for the CTOPP-2 that was used in these studies, the internal consistency coefficients for the composite scores were .85 on average (the composite score is formed by summing all of the measures that have the same underlying construct together; for instance, the memory for digits set and nonword repetition set were combined to create a composite for phonological memory). The test produces three composite scores that summarise the participant's relative standing with respect to the phonological constructs embedded in the CTOPP: phonological awareness, phonological memory and rapid naming. As given in the manual for the CTOPP-2, test–retest correlations for the core subtests ranged from .75 to .92, while those for the composites ranged from .76 to .86.

In summary, TOWRE-2 was used to measure word and nonword reading fluency, DTWRP was used to measure word and nonword reading accuracy, and CTOPP-2 was used to measure phonological processing.

3.7.3 Adapting the Tests for Use in Arabic

To address the research questions, it was necessary to find standardised tests in Arabic or create them. The researcher sent emails and made phone calls to find standardised tests in Arabic that could be used, which was challenging. Some tests were in other countries and therefore hard to access and others were accessible (i.e. in Saudi), but the researcher was not permitted to use them. As a result, it was necessary to adapt the standardised tests in English into Arabic for use in the current studies.

To adapt the test items (phonological processing, reading efficiency and reading accuracy) into Arabic, it is essential that the words to be read/heard are matched with the English versions on a number of key characteristics known to affect processing efficiency. The majority of words should not be adapted to target the meaning of the word because it is not that important, as the purpose of the tests is to assess word-level reading accuracy and efficiency, not vocabulary knowledge or comprehension. The key characteristics were the number of characters, number of syllables and number of phonemes. A reliable source of the

created tests in Arabic was required to select words that matched the English words used in the test of reading efficiency and reading accuracy. The created lists of words had to be derived from a well-constructed corpus (Buckwalter & Parkinson, 2011). The sources were found in the frequency dictionary, a list of the most frequently used words, of Arabic core vocabulary for learners (Buckwalter & Parkinson, 2011). It contains the most common 5,000 lemmas, and words in the dictionary are assigned together in their singular noun form and infinitive verb form and are based on them being frequently encountered in children's school textbooks to ensure familiarity.

For the phonological processing test, the Arabic equivalent of the CTOPP test required blending words, nonwords, segmented nonwords and repeated nonwords. Therefore, it follows that phonological structure is important to control for. Finding Arabic words that were equivalent to English in the number of syllables and phonemes was therefore crucial in creating test items.

3.7.3.1 Adapting the Phonological Processing Test (CTOPP)

Phonological Awareness.

To adapt the PA subtests (elision, blending words, phoneme isolation, blending nonwords and segmenting nonwords), the researcher first created a list of words from children's school textbooks and a dictionary of Arabic core vocabulary (Buckwalter & Parkinson, 2011) for each subtest and a list of nonwords for the blending nonwords and the segmenting nonwords.

The first subtest was elision, which was adapted by the researcher by isolating a consonant letter from the word, as was done in the English version. For example, the syllable for the word 'mat' is one in which the word follows the simple phonics rules of CVC. The child would have to say the word 'mat' without saying the first phoneme, 'm'. Correspondingly, the Arabic word كَأس/ kas also has one syllable and three phonemes (see Appendix 1), similar to the English word 'mat', and the child must pronounce the word without the first consonant (ك/ k). For another word with a different isolation letter position, such as the word 'time', CVC, the child would need to pronounce the word but without the phoneme 'm'; and, in Arabic, the word سَامي / sami has CVCV and the child needs to say the word without the phoneme (م/m). Therefore, the researcher created a list of Arabic words for this subtest that were similar to English in terms of the number of syllables and phonemes. The main difference between the Arabic and English versions was the order of vowels and consonants within each word due to the structure of the two languages. Although there was a difference

in the structure of the words, the child needed to pronounce each item after omitting a consonant in the English version as well as in the Arabic version.

For the blending words subtest, Arabic items were matched with English items in terms of both the number of syllables and the number of phonemes. For example, the word ‘cow-boy’ has two syllables and four phonemes. As a result, the researcher created a list of equivalent Arabic words in terms of the number of syllables and phonemes, such as the word ليمون/ limun, which has two syllables (li-mun) and five phonemes (l/i/m/u/n). For the blending nonwords subtest, the researcher followed the same procedure as the blending words subtest, but with made-up nonwords. The nonwords list did not consist of any familiar roots and/or patterns, and was designed to avoid any wordlikeness in Arabic.

In the phoneme isolation subtest, Arabic items were matched with English items in terms of the number of phonemes. For example, the word ‘man’ in English has three phonemes m/a/n, and the Arabic word دار/ dar has three phonemes (د-ا-ر/ d-a-r). The target phoneme that needs to be considered is the first phoneme in the word (د/d). In the word ‘train’ in the English test, the child needed to identify the second phoneme. In Arabic, for the word قليل/qlil, the child needed to identify the second phoneme, which is (ل/l). In this way, the researcher created a list of Arabic words.

For the segmenting nonwords subtest, the researcher created Arabic nonwords matched by number in phonemes and syllables for each nonword in the English segmenting subtest. For example, the nonword ‘mo’ has two phonemes, so the Arabic nonword نا /na also has two phonemes (ا/ن, n/a), and the English nonword ‘kootaz’ has five phonemes, so the Arabic nonword رمشاع/ rmshaea also has five phonemes (r-m-sh-a-ea). رمشاع/ rmshaea; the long (a/ا) in this word needs to be pronounced as long vowel a/ ا and the last letter is (ea/ ع).

Phonological Memory

The English-language test of phonological memory has two subtests: nonword repetition and memory for digits. For the nonword repetition, there were 30 nonwords with different numbers of syllables and phonemes, so the researcher created a list of equivalent Arabic nonwords by the number of syllables and phonemes (see Appendix 1). For example, the nonword ‘ral’ in English has one syllable. In Arabic, the nonword راف/ raf also has one syllable. The nonword ‘nigong’ has two syllables, ni-gong, so the Arabic nonword تثقاغ / tithqagh has two syllables (تث/قاغ, tith/qagh). After controlling for the number of syllables, any further influence of pronunciation length was expected to be small.

For the memory digit subtest, the researcher created lists of Arabic digits in the same order as in the English version, starting with two sets of numbers, such as 4-7, and building to a set of nine numbers (e.g. 4-8-7-1-3-6-9-5-2). Arabic digits have more than one syllable, but most English digits have only one. It was challenging to make Arabic digits equivalent to English digits in terms of control over the number of syllables, phonemes, or letters within the numbers. Therefore, the memory digits subtest in Arabic was created based on the number of digits in each set in English. This must be taken into account when it comes to the interpretation of the findings of the current studies.

Rapid Naming

The researcher adapted the RAN test to include items with Arabic numerals and Arabic letters. For each subtest, nine different items were used, each repeated four times in the array, as in the English version. Each Arabic letter has one phoneme and one syllable. Therefore, in the test of rapid letter naming, the child needs to say the names of the letters. There were no differences between pronouncing letters in English and Arabic in terms of phonemes and syllables because the child needs to say the sound for each letter, such as 't' in English or 'ت/t' in Arabic. However, most Arabic digits have more than one syllable, unlike English digits, so items were not matched on number of syllables or phonemes (see Table 3.5).

Table 3.5

Mean Number of Phonemes, Syllables and Characters in English and Arabic Versions of the RAN Digit Task

RAN Digit	English	Arabic	*t*	*p*
Phonemes	2.67 (.76)	3.33 (.65)	-3.33	.002
Syllables	1.17 (.38)	1.50 (.51)	-2.65	.01
Characters	4.33 (.76)	4.67 (.76)	-2.65	.01

Note. 36 numbers; standard deviations in parentheses

Table 3.5 shows that the difference between English and Arabic in numbers of phonemes, syllables and characters is significant. Therefore, it was necessary to control for this difference when calculating scores across the two languages. Rather than reporting the overall time to name the digits, the time per syllable was calculated for both versions of the

RAN digit task. First, to find the average time for rapid digit naming scores per syllable, the total number of syllables across all items in the test was taken and then divided by the number of items. The number of syllables for the English task was 42 syllables, while in the Arabic task, there were 54 syllables. For English, the mean time was divided by 42, and for Arabic, the mean time was divided by 54. This calculation helps in the analysis of the results for the RAN digit by controlling for the higher number of syllables in Arabic digits.

3.7.3.2 Adapting the Test of Word Reading Efficiency (TOWRE).

An important consideration in adapting this test was to keep the same number of phonemes, syllables and characters across the English and Arabic versions. Although the frequency of exposure to the words is important, the researcher did not control for the measures of word frequency in comparing languages. When creating a test that is equivalent in two languages, there are many linguistic variables that ideally should be matched. Ideally, words in the two tests would be matched on frequency because word frequency has a significant impact on reading time (Gerth & Festman, 2021). However, matching words on other linguistic characteristics was even more important, because in the current studies the aim was to assess participants' phonological processing abilities and their ability to read accurately and efficiently at the word level. Therefore in ensuring that words were matched on word length (in terms of phonemes and syllables), unfortunately it was not possible to match them perfectly on frequency. This is a limitation of the current research but also an unavoidable one. The words in the current adapted list start from two letters in length and gradually increase in terms of increasing word length.

All the adapted Arabic reading words were vowelised, as this test measured word-level reading efficiency and accuracy. This is because without diacritics, words can be ambiguous when read out of context. These principles were adapted for all the words and nonwords in the subtest (see Table 3.6).

Table 3.6

Mean Number of Phonemes, Syllables and Characters in English and Arabic Versions of the Word Reading Efficiency (TOWRE) Task

TOWRE Words	English	Arabic	*t*	*p*
Number of phonemes	5.98 (2.53)	5.97 (2.52)	1.00	.32
Number of syllables	1.90 (.93)	1.94 (.89)	-1.91	.06
Characters	6.06 (2.48)	6.14 (2.44)	2.18	.03

Note. 108 words; standard deviations in parentheses

The mean number of phonemes per item in the sight word efficiency subtest of the reading efficiency test was not significantly different from the original English version. There was a significant difference only in the number of characters in the words, the Arabic words being longer than the English words, although the difference in the number of syllables was marginal. For the nonword reading subtest, the nonwords were obtained from real words, with one or more letters changed in certain words so that the words had no meaning (see Table 3.7).

Table 3.7

Mean Number of Phonemes, Syllables and Characters in English and Arabic Versions of the Nonword Reading Efficiency (TOWRE) Task

TOWRE Nonword	English	Arabic	*t*	*p*
Phonemes	4.61 (2.23)	4.77 (1.89)	-2.02	.06
Syllables	1.53 (.79)	1.53 (.75)	.001	1.00
Characters	5.32 (2.53)	5.24 (2.33)	1.93	.06

Note. 66 words; standard deviations in parentheses

The number of phonemes, syllables and characters per item in the nonword subtest of the reading efficiency test did not significantly differ between the original English and the Arabic versions, although the difference was marginal for phonemes and characters.

3.7.3.3 Adapting the Diagnostic Test of Word Reading Processes (DTWRP).

Adapting the nonwords and regular words in the reading accuracy test followed the same procedure for the phonemic decoding and sight word subtests in the TOWRE (see Tables 3.8 and 3.9).

Table 3.8

Mean Number of Phonemes, Syllables and Characters in English and Arabic Versions of the Nonword Reading Accuracy (DTWRP) Task

DTWRP Nonwords	English	Arabic	*t*	*p*
Phonemes	6.47 (2.58)	6.37 (2.39)	1.36	.18
Syllables	2.07 (1.05)	2.03 (.96)	1.00	.33
Characters	6.43 (2.49)	6.27 (2.43)	1.31	.20

Note. 30 words; standard deviations in parentheses

No significant difference emerged between English and Arabic in phonemes, syllables or length.

Table 3.9

Mean Number of Phonemes, Syllables and Characters in English and Arabic Versions of the Regular Word Reading Accuracy (DTWRP) Task

DTWRP Regular Words	English	Arabic	*t*	*p*
Phonemes	5.43 (2.37)	5.47 (1.98)	-.24	.81
Syllables	2.07 (1.05)	2.10 (1.03)	-1.00	.33
Characters	6.47 (2.58)	6.13 (2.59)	1.24	.22

Note. 30 words; standard deviations in parentheses

The results indicate no significant difference between English and Arabic in the number of phonemes, syllables and characters in the regular word reading subtest. However, when adapting the exception words reading subtest for the reading accuracy test, it was difficult to find equivalent Arabic words because Arabic is highly consistent, with each letter corresponding to a single sound. The exception words were removed from the reading accuracy test.

3.7.4 Pilot Study

A pilot study was performed prior to the actual data collection. Six bilingual children were included; two were 8 years old, two were 10 years old, one was 11 years old and one was 12 years old. These children did not participate in the main studies. All children completed the Arabic and English reading efficiency and reading accuracy tests and the comprehensive testing of phonological processing. In addition, five monolingual Arabic speakers were tested; two children were 8 years old, one was 9 years old, one was 10 years old and one was 11 years old. The pilot research was carried out in advance to verify the suitability of the tests for use with the target samples in the research and to obtain information on time management. The internal reliability of all items was satisfactory. The Arabic reading efficiency task produced a Cronbach's alpha score of .95. The reading accuracy task showed a Cronbach's alpha value of .95. The PA task showed a Cronbach's alpha value of .91. The PM task led to a Cronbach's alpha score of .90, and the RAN task produced a Cronbach's alpha score of .90. This means that the tests had high internal reliability.

The results of the pilot study (see Appendix 2) showed that the reading assessments were suitable for bilingual children and monolingual Arabic children. There was no significant difference between the English and Arabic scores for bilingual reading efficiency, reading accuracy, PA, PM, RAN letters, and RAN digits. Comparing bilingual and monolingual children, no significant differences were identified in reading efficiency and reading accuracy, nor in PA, PM, or RAN (digits and letters). By administering reading and phonological processing tests to the pilot group, the researcher was attempting to ensure that the adapted tests in Arabic were appropriate for bilingual and monolingual children. However, the HLQ was not administered to the pilot group, therefore there was insufficient information to describe the two pilot groups' language background in more detail.

The only change made following the pilot study was in the font size of the adapted Arabic test for reading efficiency and reading accuracy. Since all children in the pilot study were able to read and understand both the English and Arabic tests in the time given, the tests were used in the main studies. After matching Arabic with English word and nonword test items on the number of phonemes, syllables and characters, the Arabic versions of the tests were found to be suitable for use with Arabic native speakers after piloting these tests with bilingual and monolingual children.

The next section describes the differences between the results obtained from the adapted tests and compares the participants' score results with the English monolingual

standardisation sample found in the tests manual to examine to what extent the adapted Arabic tests show a similar pattern to the original standardisation sample of monolingual English-speaking children.

3.8 Ethical Considerations

A key aspect of any research study is ethics. Ethics are more than just a set of principles or abstract rules that guide our research. Ethics exist in our behaviour and in our study methods (Davies & Dodd, 2002). Ethics are vital for the quality of research because they help researchers avoid biases, increase the accuracy of information and use accepted methodology (Cohen et al., 2011). As human participants were studied, and children in particular, research ethics were essential for this study, including voluntary informed consent and confidentiality.

Formal procedures were required and carefully followed before the study was conducted. Ethical approval was acquired from the Research Ethics Committee of the Institute of Education and from the relevant section of the Administration of Education Office in Jeddah, which is under the supervision of the Ministry of Education in Saudi Arabia, before any data were collected. A copy of the ethical approval can be found in Appendix 4. Once the project was allowed to proceed, the headteacher was informed about the details of the study and invited to take part. A copy of the informed consent form for the headteacher is presented in Appendix 5. With the headteacher's consent, information letters and (opt-out) consent forms were sent to the parents, and only those children whose parents had given consent were invited to take part in the study. The children were also provided with an information sheet and asked for their consent to take part.

It is clear that assessing children's competence is not straightforward; understandings of and attitudes towards competence vary among researchers, and assessments of competence are dependent on the complexity and risks inherent in the research being conducted (Ensign, 2003; McCarthy & NetLibrary, 1999). Alderson (1995) noted that one way around these problems is to assume that school-age children are competent and that the responsibility is then on parents who disagree to prove incompetence (Alderson, 1995). Masson (2004) noted that a researcher could be at risk of legal proceedings brought by parents if they involved a child younger than 16 years of age in social research without having acquired parental permission. As this research was carried out with children under the age of 16, it was crucial that both child and parental consent be given freely. All the parents of children in Grades 3, 4, 5 and 6 were given an information sheet that fully described the purpose of the study, the benefits and risks of taking part, what their child would be asked to do if they took part, and

what would happen to the data collected, together with the opt-out consent forms, in Arabic and English languages. The researcher translated the English information sheet and the opt-out consent form into Arabic, and these were approved by two Arabic teachers. After sending the information sheet and the opt-out consent, the researcher waited five working days before starting to recruit the children to ensure that the parents had enough time to read the information sheet (see Appendix 6).

After obtaining permission to collect data from the headteacher and parents, the arrangement to meet the participants was made with the classroom teacher, excluding the children whose parents did not agree to take part in the research. All of the children who took part in the study were provided with the information sheets and the researcher explained to the children what the study was about and what would be involved in taking part. A copy of the information sheet for the children is presented in Appendix 7.

Informed consent is a continuous procedure that lasts for the duration of study involvement. This means that a child who agrees to participate can change their mind and withdraw agreement at any time, and this also applies if their parent wants them to stop taking part. This issue was fully explained in the parents' information sheet. Risks that the children might face during assessment were getting tired or experiencing distress. If that happened, the researcher planned to give the child a break. If they did not want to continue after a break, they were reassured that they could withdraw and that this would have no effect on their schoolwork record or anything else. In the study, none of the children became tired or stressed. In fact, they were happy to take part in the study.

It is often difficult to conduct ethical research with young children, and it is even more difficult if the children have special educational needs since these children can have a wide range of difficulties. Each child must be considered on an individual basis to ensure that their voice is heard while the researcher decides on the most effective testing methods (Ellis & Beauchamp, 2012). The researcher made sure that the children understood what they were agreeing to by explaining it several times. The researcher in this study ensured that the environment was comfortable for the children by continually reassuring them that the scores did not indicate any intellectual abilities and did not represent them as a person. This helped to reassure the children in this study, which led to them enjoying the tests and being happy to participate in something that could possibly benefit them in the future.

To ensure the confidentiality and privacy of the participants, all the data were anonymised, and no children's names were collected. Although school names were known to the researcher, they do not appear in any documentation and are not mentioned in this thesis. All the data were kept safely and confidentially in a locked place by the researcher, as this research was purely for academic purposes.

Typical developing bilingual children and monolingual children were tested individually in a quiet room at school during a single session lasting not more than 50–55 minutes for each language and only Arabic was tested for the monolingual children. The child was given a break after finishing the Comprehensive Test of Phonological Processing in each language. They were also given breaks during the testing as needed. Before each task, participants were asked to choose which language they preferred to start with, English or Arabic, for bilingual children in Study 1 and children with reading difficulties in Study 2. The tests used in these studies were administered in two stages: English then Arabic, or the reverse. Before taking the tests, the students were asked to complete the Home Languages Questionnaire. This was administered orally by the researcher, and the children were asked if they preferred to respond in English or Arabic. This took approximately five minutes to complete. Subsequently, the first stage involved measuring word reading proficiency using the TOWRE, the DTWRP and the CTOPP-2 in English. In the second stage, children were assessed in Arabic using the adapted reading efficiency, word reading accuracy and phonological processing. The tests were administered in the same order for every child and all children completed all three tests in one language before moving on to the other.

The bilingual children with reading difficulties in Study 2 required more than one sitting to complete all the assessments, as they had the same reading and phonological processing tests as those in Study 1 as well as an IQ test. The children received more breaks than those in Study 1. If a child became tired or distressed, the researcher would stop testing and take the child to their teacher or SEN teacher. However, this did not occur.

This study is informative for the field and contributes to potentially benefiting children, parents and teachers because it provides a better understanding of reading difficulties in bilingual children in the KSA and of learning difficulties in particular. The benefit of this study is that it contributes to positive outcomes; it enhances knowledge of the importance of using reading accuracy, reading efficiency and phonological processing skills to assess bilingual children's reading ability.

3.9 Summary

The main goal of this chapter was to present an outline of the research methods used and to describe the procedures adopted to collect the data. A quantitative approach was selected as an appropriate design to answer the research questions. The research was carried out in the UK and Saudi Arabia within different primary schools. The sample comprised typical bilingual Arabic–English children, monolingual Arabic-speaking children and bilingual children with reading difficulties. The procedures for adapting the tests into Arabic and the comparison of the English and Arabic versions of the tests have been described in detail, and the results obtained from comparing the adapted tests with the standardised sample have also been discussed. The procedure was different for each study, so this will be described separately within each empirical chapter. The ethical considerations of the research were also addressed. This summary completes the discussion of the research methodology utilised across the three studies. The first study of bilingual children and monolingual children is presented in the following chapter.

Chapter 4 Study 1

4.1 Introduction to Study 1

This study focused on typically developing Arabic–English bilingual children in the KSA and UK to identify the patterns of word reading difficulties and strengths in each language, which were then compared to monolingual Arabic children to inform the field on how these students perform in reading and phonological related tasks.

This section briefly presents previous research on developmental reading and reading-related skills in English, Arabic and more transparent orthographic systems such as Spanish, Italian and Greek. Follow describe the education system in Saudi Arabia, phonics versus whole language teaching, language exposure and, finally, a brief discussion of the predictors of reading.

4.1.1 Comparison of Reading Performance in Two Languages in Bilingual Children

The ability to read in one language influences the development of reading skills in another language (Geva, 2006). Bilingual children may only need to learn to decode in one language and then apply these skills to reading in their second language (Yamashita, 2004). This may be because once they grasp the principles of grapheme–phoneme correspondences in an alphabetic language and orthographic patterns in one language, they can make use of them in their second language more easily (Bialystok, 2005). If their L2 uses a different alphabet, they have to learn the new set of symbols and the sounds they represent.

A study by Jamal et al. (2012) sought to identify the anatomical areas of the cerebral cortex involved in single word reading in each language for Spanish–English bilinguals. Evaluation of the brain areas using functional magnetic resonance imaging showed that the left inferior frontal and middle temporal gyri were activated while communicating in Spanish. In contrast, speaking in English activated the left inferior frontal, middle frontal and fusiform gyri, as well as the right middle temporal gyrus. The study revealed that reading in Spanish recruits the superior temporal gyrus, while speaking in English involves the left middle frontal gyrus. Therefore, differences in orthographic transparency cause language-specific variations. English, for instance, may require more frontal involvement because it is orthographically deep, while Spanish requires more middle temporal areas for processing speech, showing that some differences in the brain regions are involved in processing Spanish and English (Jamal et al., 2012).

Across alphabetical languages, the development of PA can be transferred from one language to another (Adams, 1990; D'Angiulli et al., 2001; Gillon, 2004; Wang et al., 2006). Comeau et al. (1999) in a longitudinal study, investigated the relationship between PA and reading achievement in English and French speakers (N = 122). The children were enrolled in immersion programmes for one year and were native speakers of French learning English as an L2. Decoding skills and phonological processing were assessed in both languages. In the longitudinal analysis, the children were reassessed. They found that PA in French (L1) had a strong association with reading achievement in both English and French. Moreover, PA abilities in the two languages were strongly correlated at both Time 1 and Time 2. Most studies (Cisero & Royer, 1995; Comeau et al., 1999; Durgunoğlu et al., 1999; Lafrance & Gottardo, 2005) have indicated that bilingual typically developing children's PA in their dominant language may transfer to their L2.

The orthography of the Arabic language in bilingual students influences the reading process. Ibrahim et al. (2002) researched whether complex Arabic orthography increases the time taken to recognise a word. The study population was native Arabic Grade 10 pupils studying Hebrew as a second language. The children completed the Trail Making Test (TMT), which is a neurophysiological test that measures processing speed and attention and cognitive functions, among other things. The children completed the TMT both orally and visually (Partington & Leiter, 1949) in both languages (Arabic and Hebrew). The oral TMT required that consecutive numbers be declaimed or that numbers and letters be alternated. The visual TMT required universal digits (1, 2, 3) or Indian/Arabic numerals (١،٢،٣) connecting, and a change between letters and numbers.

They determined that processing letters was faster in Hebrew, while processing universal numerals was faster than Arabic numbers. These findings were ascribed to the fact that Arabic uses Hindi numerals (١،٢،٣), which differ from universal numerals (1, 2, 3). In addition, the participants were equally proficient in oral performance in both languages. This demonstrates that visual rather than phonological variables are the key drivers of variations in visual letter and number processing in Hebrew and Arabic. Therefore, the fact that universal digits are utilised for arithmetic while Hindi digits are employed only in written texts explains why universal Roman digits result in better performance than Hindi digits. In the current study, as mentioned in the methodology section (3.4.1), in the international schools in both the KSA and UK, arithmetic was taught in English using universal numbers (1, 2, 3). Arabic numerals (١،٢،٣) were found only in the Quran and Arabic books.

The threshold hypothesis developed by Cummins (1979) claimed that it might be difficult to indicate that literacy skills transfer from L1 to L2 below a certain degree of L1 language proficiency. This hypothesis proposes that the successful development of reading skills in the L1 is transferred to the L2. However, Saiegh-Haddad and Geva (2010) claimed that transfers are not bidirectional and may be more likely to occur from the stronger language to the weaker language than vice versa.

Language can be easily transferred from L1 to L2 when both linguistic characteristics share similarities in the languages, as the students are aware of some aspects that are common to the two languages, such as phonological forms (Comeau et al., 1999; Sun-Alperin & Wang, 2011). Unlike French and English, Arabic and English do not share an alphabet, so this raises questions about cross-linguistic transfer in reading and spelling. Hussein (2014) investigated the influence of learning English (L2) on reading and spelling accurately in Arabic (L1) by measuring the reading and spelling accuracy of 45 bilinguals (Arabic–English) and 38 monolinguals (Arabic) in Grade 4. English was taught as a subject in addition to other subjects, and all students retained the Arabic language as their mother tongue. English (L2) was also used as the language of instruction for science and mathematics among bilingual children. The results indicated that students who were taught in Arabic and English performed better in reading and spelling accuracy in Arabic than their monolingual (Arabic) counterparts. The study concluded that reading and spelling in English L2 have a strong impact on the accuracy of reading and spelling in Arabic (L1).

Significantly, for this study, children received intense and frequent L1 exposure, which was monitored carefully. Bilingual children were taught Arabic in some subjects, such as Islamic and Arabic language, and were taught English language, science and mathematics in English. However, the researcher measured reading and spelling accuracy and did not consider other variables, such as reading efficiency and phonological processing ability, which are included in the current study (covering reading efficiency, reading accuracy and phonological processing skills). The next section briefly discusses the education system in Saudi Arabia.

4.1.2 Education System in Saudi Arabia

Bilingual education programmes have expanded worldwide (Montanari et al., 2016). Cameron (2001) reported that over the last two decades, the number of English lessons, particularly for young children in Europe and South America, has increased. Primary curricula have been revised in East Asian countries, including China, to include English

instruction (Qiang, 2002). In most Gulf countries, English is the primary language of instruction. Many native Arabic speakers send their children to private primary and secondary schools abroad, especially where English is spoken as the native language (Ali, 2009; Randall & Samimi, 2010), to enhance their higher education and employment opportunities. Most private universities in the KSA require a certain level of English language proficiency, and medical schools in the KSA use English as the primary language of instruction (Belhiah & Elhami, 2015). The Saudi educational system is focused on learning a second language, particularly English, due to business requirements and international needs, as English is a global language for industry, science and technology.

English studies differ from one school to another in Saudi Arabia, and not all schools follow the same system of teaching English. In public education, children have to start learning English as a subject in Grade 4, but the Saudi Ministry of Education has stated that English language instruction will begin in Grade 1 of primary school in the coming academic year 2021/2022 (Department of Media Centre at the Ministry of Education, 2021). In private schools, children have two options. They can learn all subjects in Arabic and English as a foreign language for only three lessons per week, or they can go to a private international school where English is the dominant language taught alongside Arabic. As such, children study all subjects in English except Islamic studies and the Arabic language. The bilingual children in the KSA attended international schools and the monolingual children attended a private school.

Alfaraidy (2020) conducted a study with Saudi parents of students in international schools in the KSA to learn about the variables influencing their decisions on where to send their children to school. The study showed that the parents had practical priorities when it came to sending their children outside the KSA for university; they were particularly focused on the type of curriculum taught and the school's overall quality. Teaching children at international schools has proven to be the most important factor in getting parents to send their children to study abroad for university (Alfaraidy, 2020). With regard to curriculum and overall school quality, the facilities and administration of international schools were found to be less relevant considerations. Of the estimated 7.7 million school-age students in Saudi Arabia, 11.7% attend private schools, 5.6% attend international, while the remaining 82.7% are enrolled in public schools (Ministry of Education, 2021). These percentages reflect the number of schools, as 83% of schools are public and 17% are private and international. The

percentage of students attending private schools is expected to increase to 15% by 2025 (Strategic Gears Management Consultancy, 2018).

The demand for private schools has been rising rapidly since the beginning of the 21st century in the KSA, since the government started to support them financially by providing 50% of teachers' salaries and free textbooks for children (Aldosari, 2022). Therefore, the number of pupils studying in private schools has increased rapidly. In 2018–2019, there were 72,843 private school students, compared to 8,306 in 2010–2011 (Department of Statistics at the Ministry of Education, 2019). It is evident that a great number of families prefer private schools, where their children are taught in languages other than Arabic. Upon entrance into the school system, these children usually learn a second language, most commonly English, and use it exclusively for school purposes. Good schools in Saudi Arabia, according to Howell (2014), are private international schools that charge excessive fees, leading to superior private education being available only to the wealthy. Particularly noticeable is the discrepancy in Saudi Arabia between the public and private sectors. Saudi Arabia's public schools depend largely on rote learning and memorisation and do not cover other topics like theatre and music. Also, in international schools, there is no gender segregation in the classroom.

There are a number of reasons why parents send their children to international schools. The philosophy that international schools facilitate global transformation in developing countries implies that national education and its results depend on the nature of the proposed international education. It is suggested that for families who would prefer their children to have a bilingual education and the resulting opportunities, the best option is an international school. MacKenzie et al. (2003) explored parents' attitudes towards international schooling in Switzerland and discovered several factors that affected their decisions: English language proficiency, opinions about the school, facilities, impression of the school, previous experience with international schools and school examination results. Overall, English was the largest factor determining parents' decisions, with their perceptions of the school coming second.

The international curriculum has recognised the importance of providing a school policy on the language of instruction, which is generally English. Alfaraidy's (2020) research showed that the curriculum is the most essential factor in helping parents choose international schools for their children, and parents in the KSA prefer to enrol their children in international schools to obtain the benefits of speaking, communicating and developing a

bilingual education. The next section explains the two different teaching methods involved in learning to read: the phonics method and the whole language method.

4.1.3 Teaching Phonics vs. Whole Language Method

There has been much debate over which method is the ideal approach to teach reading (DeFord, 1985; Stahl, 1997), which may influence how individuals view phonics instruction. For some, having the ability to locate every word in a text yields an appreciation of the content. Understanding the meaning of the text is the ultimate goal when it comes to teaching reading (Gough & Hillinger, 1980). However, others believe that whole-text interpretations should begin with the reading process and that phonics should only be used to aid the reader's goal of understanding the text (Goodman, 1993). Approaches to phonics teaching differ based on different belief systems. This thesis focuses on word reading rather than comprehension. These issues will be discussed further below.

Phonics is one of the methods used to teach reading. According to Goodman (1976), readers use three different types of cuing when they encounter words within meaningful text: syntactic, semantic and graphophonemic. His concept is built on his study of miscue analysis, which is the investigation of reader error during reading (Goodman & Goodman, 1977).

Whole language instructors have advocated for teaching children about letter–sound correspondences, but only as a supplement to their continuous process of decoding or generating text. Instructors in whole language programmes, instead of teaching in a fixed, predetermined order, provide students with the knowledge to read the text, as discussed next.

4.1.3.1 Whole Language Approaches.

A whole language approach emphasises the discovery of meaning through experience in an environment rich in reading (Goodman, 1967). The whole word approach is a way to train children to read and remember words. This technique treats whole words as logos or signs, word by word. The reader visually recalls the shape of a word, rather than individual letters or sounds (Balmuth, 1982; Goodman, 1986). For example, in a certain text, the teacher can draw attention to the word *chair* and ask pupils if they hear words that rhyme with chair. The (ch) is not recognised as an isolated spelling of a sound but only in the context of a word.

As an alternative to systematic phonics programmes, whole language methods have surpassed the whole word approach. The transition entailed a shift from very little letter–sound training in first grade to a smattering of letter–sound instruction provided haphazardly. It is not required for whole language instructors to wait until a particular age before teaching

children about letter–sound associations. They generally include some phonics teaching in their lessons, either as part of creative spelling games or through the use of graphophonemic cues while reading (Routman, 1996). Their method is to teach it unsystematically when the need arises. Instruction in vowel letter–sound correspondences seldom occurs in whole language approaches (Stahl et al., 1998). This is in contrast to systematic phonics programmes, which place a premium on teaching vowels as part of the decoding process (Shankweiler & Liberman, 1972).

As a result, some whole language teachers believe that they should never teach words in isolation and that it is better to teach phonics only when children show a need for it. These whole language educators also believe that nonauthentic materials, such as decodable texts, should not be used in education. However, experienced whole language instructors frequently break these principles (McIntyre & Pressley, 1996; Mills et al., 1992; Pressley et al., 1996).

4.1.3.2 Phonics Method.

Early and deliberate attention to the training of word decoding is more successful than a less structured approach, according to research (Adams, 1990; Chall, 1996; Ehri & Nunes, 2001). Teaching children to decode words so that they can independently learn words, allowing them to become good readers, is crucial for children to develop as independent word learners and to read without the support of teachers (Share, 1995).

Synthetic phonics programmes typically start by teaching children a small set of simple grapheme–phoneme correspondences, and they are taught to combine each phoneme to create words early on (Castles et al., 2018; Johnston & Watson, 2005). Rose (2006) examined reading strategies and determined that synthetic approaches were the best way to teach all children to read. Rose's (2006) recommendation in the UK is that early reading must contain synthetic phonics.

Analytic methods start with a word that a child is familiar with and break it down into its constituent components (Durkin, 1988). The synthetic phonics method is the other main category of conventional phonics approaches. Individual letters or groups of letters are taught to students, and they are then instructed on how to blend these letters together to form complete words (Rose, 2006).

English uses a complicated alphabetical code, which is why a systematic method, from the simple to the more complex, is required to teach English reading. Children should understand the basic functions of alphabetical writing before they approach the complexity of English.

Therefore, to master the alphabetic concept, a child must understand words not only in terms of meaning but also in terms of the sounds they represent (Stahl & Murray, 1998). Reading instructions that utilise phonics training programmes seem beneficial for both typically developing children and children with reading difficulties so that children get higher scores on reading achievement (Ehri, Nunes, Stahl, et al., 2001). Ehri et al. (2001) described four activities—rhyming, segmentation, blending and initial/final sounds—and stated that at least one should be included in a successful phonics method. Blending, for example, involves having the children sound out the spelling of a word; 'mad' could be sounded as 'm-a-d' and slowly sounded out together until the word is pronounced correctly. These activities should be included because they help children become skilled readers by decoding words.

Often, before introducing letter sounds, phoneme awareness is presented to children as a prerequisite, despite the fact that it is typically regarded as manipulating spoken words. It can be assumed that a programme that starts with the child listening to a word and saying the first sound is attempting to help with phoneme awareness; however, this is insufficient for children with severe phonological delays (Stahl et al., 1998).

In general, studies have indicated an advantage for synthetic methods over analytic methods. An understanding of the differences between analytic and synthetic approaches allows us to understand how children in the KSA acquire reading instruction and which method they should follow.

4.1.4 Reading Instruction in the KSA

Despite the widespread belief that reading is one of the most essential educational tools in the classroom, there is a significant vacuum in the research addressing strategies used to develop the reading abilities of young children in Saudi Arabia (Islam & Eltilib, 2020). In the KSA, reading instruction is given to the whole class, and basal readers do not always meet the needs of individual pupils. This structure does not offer a diversity of teaching approaches for different types of learners (e.g. children with reading difficulties and gifted children; (Puorro, 1997). In public schools and most private schools in Saudi Arabia, the Elementary National Reading Programme allows for the systematic development of literacy skills. The teaching of reading and literacy is planned in four phases: (1) planning by teachers, (2) initial reading and decoding in the first two grades, (3) consolidation and fluency in the next two grades and (4) mastering reading in the higher grades.

The basic curriculum in Saudi Arabia is based on the conviction that a child's language, which is spoken, read and written, should naturally be derived from teaching it and be used to communicate real needs. The teaching materials' basic approach is balanced and encompasses analytical, synthetic and whole language approaches (Al-Jarf, 2007). Learning to read in Saudi Arabia begins with the task of recognising letters as the components of words. First graders spend their early school years studying one letter at a time and completing simple activities to help them understand letters and their forms (beginning, middle and end). By the end of Grade 2, children know all the letters and their forms. Rather than mapping letters to sounds and reading them, instructors in Saudi Arabia are encouraged to emphasise the whole word, with letter instruction kept separate from words. No one practices decoding until they are in Grade 1 at about the age of six, and even then, they do it by trying to pronounce the letter sounds and vowels together. Whole word reading is greatly favoured (Al Ghanem & Kearns, 2015).

According to Al-Jarf (2007), there are no clear instructions for setting and tracking reading development, and there are no standardised reading tests to assess reading development or the effectiveness of the basal readers and reading instruction provided to the children. As a result, there is no preference for teaching method in Saudi Arabia, and most independent schools choose to use different methods of teaching reading, as shown in the current thesis. The international schools in this study used the whole language approach to teach Arabic reading and the phonics method to teach English reading. Private schools in the current study teach Arabic reading using the phonics approach. Therefore, a key difference between the monolingual and bilingual groups in this thesis is the way in which they were taught to read. The next section briefly discusses the predictors of reading in Arabic

4.1.5 Phonological Processing Ability As Predictors of Reading Skills in Arabic

Al-Mannai and Everatt (2005) examined the predictors of literacy skills among typically developing monolingual Arabic-speaking Bahraini children (N = 171, ages ranging from 6.25 to 10.42 years). Measures of PA, short-term memory, speed of processing, nonverbal ability and nonword reading were administered. The results showed that for older children, their performance on nonverbal tasks was a predictor of reading skills in Arabic un-vowelised texts. The researchers suggested that this is because non-vowelised texts are difficult in the early stages of reading and writing and older children depend on their necessary nonverbal skills for processing texts, such as those that are based on context as well as rich morphology. Regression analysis showed that PA and decoding were the best predictors of both reading

and spelling when other phonological processing variables were controlled, especially for beginner readers. This is evidence that PA is a necessary foundation for early literacy among Arabic-speaking children.

Another study by Tibi and Kirby (2018) investigated PA and naming speed as predictors of reading skills in Arabic-speaking children ($N = 201$, 8 years). The children were assessed on nonverbal ability, verbal ability, vocabulary, PA, naming speed and reading skills. To predict reading from PA and naming speed, hierarchical regression analyses were carried out. The results showed that both the PA and naming speed measures contributed unique variance to reading outcomes. These results are in line with results from the previously reviewed studies on monolingual English-speaking children that suggest PA is a strong predictor of reading.

Another recent study confirmed that PA is a strong predictor of reading skills in Arabic. Hassanein et al. (2022) investigated the link between phonology, orthography and morphology in Arabic word reading to determine which early reading abilities account for the largest variation in word reading for readers in Grades 1 and 2. The findings revealed that PA, especially elision, is a major predictor in the early grades. When word reading accuracy and vowelised and un-vowelised word reading were the outcome measures, phonological memory accounted for unique variation in reading accuracy but not in reading fluency. Un-vowelised word reading ability and word reading fluency were both statistically significant predictors of RAN. Throughout all of the studies, phonological awareness was found to be a statistically significant predictor. Word reading ability in Arabic is influenced by phonological awareness. Hassanein et al.'s (2022) study used a new assessment that did not yet have norms, and it confirmed the demand for Arabic standardised measures to assess reading skills.

However, not all studies support the view that PA training improves reading development. For instance, (Dallasheh-Khatib et al., 2014) conducted a study to investigate the effectiveness of PA training on Arabic-speaking children's subsequent reading performance. Fifty-four kindergarten children (5 years old) involved in this study were divided into two groups: the experimental group ($N = 29$) received PA training, while the control group ($N = 25$) did not. The intervention programme was based on the methods of (Lyster, 2002), and include the use of rhymes, blending, segmenting and general sound recognition. The intervention lasted eight weeks, with three sessions of 30–45 minutes each week. Prior to and after the instruction, the children were assessed on a range of PA skills, and tests of general

abilities and reading tests were administered at the beginning of the second trimester of the first year of school. The results revealed that there was no significant improvement across the intervention period for either rhyme matching or syllable counting skills. The most striking result to emerge from this study was that the experimental group improved in certain PA skills (final phoneme matching task and phoneme counting) at the end of kindergarten compared to their peers in the control group. However, there were no significant differences in the performance of the two groups in reading. The researchers attributed the results to the assumption that typically developing Arab children encounter nonphonological difficulties in the acquisition of reading due to factors related to the characteristics of Arabic, such as diglossia and the orthographic patterns of written Arabic words. The results of this study are in contrast with the substantial literature on reading development in monolingual English-speaking children, which has generally found that phonological intervention programmes in kindergarten enhance the subsequent development of early reading abilities (Brennan & Ireson, 1997; McGuinness et al., 1995). The categorisation of Arabic (vowelised) as a transparent orthography is perhaps not helpful, as other characteristics of it make it hard to learn, so we should not expect Arabic children to perform in the same way as children learning transparent alphabetic orthographies such as Finnish or Italian.

To summarise, there has been an increase in the number of people who enrol their children in the private education system in the KSA, especially in international schools. Both the phonics method and whole language approach are necessary to develop children's reading. In the KSA, international schools favour using the whole language method in teaching Arabic reading, while private schools favour the phonics method.

To add to these studies, the research questions asked in this study are as follows:

1) Are there differences between Arabic and English in word reading (accuracy and efficiency), PA, PM and RAN in biliterate Arabic–English children?
2) Do the biliterate children and monolingual Arabic children differ in measures of Arabic word and nonword reading accuracy and efficiency and phonological skills?
3) Does phonological processing ability (PA, RAN and PM) predict reading efficiency and reading accuracy in monolingual children in Arabic?

4.2 Methods

4.2.1 Participants

For the biliterate participants, two schools were in the UK, School A and School B, and one was in the KSA, School C. All were independent private schools. The schools were chosen based on existing bilingual education policies, apart from the Saturday school (School B). At Schools A and C, subjects such as mathematics and science were taught in English, while literacy skills were taught in both Arabic and English. School B was a Saturday school and taught only in Arabic. Before selecting the participants for the study, each headteacher was contacted and briefed on the purpose of the study. Subsequently, the information and consent form was given to students in school to take to their parents. Any parent who did not agree had to return the form stating they did not want their child to take part. To make sure that all parents received the form, the researcher sent a reminder letter so that she could be sure that they had not forgotten or not seen the form. After five working days, the researcher began testing the children individually.

The researcher planned to recruit all the bilingual children from School A in the UK, but since the study was carried out at the end of the school year, the school needed to set exams for the students, so they called for the study to be postponed until the next academic year. This was not possible, so the researcher decided to go to other schools instead. Therefore, Saturday School B was selected, and all children aged 8-12 were invited to take part. As participant numbers were still low, School C, an international school in the KSA, was approached. A different number of children were included from each school because it was not possible to recruit a sufficient number of children from a single school. This also meant that, contrary to intentions, the children in Study 1 came from three quite different types of schools: one private bilingual school in the UK, one Saturday school in the UK and one private bilingual school in the KSA.

It would be expected that levels of proficiency in English and Arabic would vary a lot among the 'bilingual' children in the selected schools, hence all the difficulties regarding categorising children as biliterate/bilingual. However, the results for all the participants showed large variances and included some very low scores in Arabic for bilingual children on the reading measures, suggesting that some of the participants were not fully biliterate. Therefore, it was necessary to find a procedure to identify and remove participants who were unlikely to be fully biliterate and to redo the analyses to discover whether there were

differences between the results with and without these participants. To begin with, it was necessary to select children who were biliterate from the 76 participants.

To select such a sample, it was necessary to identify and exclude children who did not meet a basic threshold for reading skill in either of both languages. It was decided to use the reading accuracy of 'regular' words as the proficiency criterion, as nonwords can be argued to be inappropriate for assessing proficiency in reading, as the English orthography is inconsistent compared to the Arabic language.

A child was considered a poor reader if their score on the regular word reading measure fell more than 1.5 standard deviations below the mean. For English, the cut-off point was based on data from the English test norms manual of the DTWRP (see Appendix 8). There are separate norms for males and females presented in the DTWRP manual, which the researcher followed. For Arabic, the cut-off point was based on the monolingual cohort's regular word reading data obtained from monolingual children. The data used were from monolingual children in the current study, as these were the only data that were available (see Appendix 9). Any child scoring below the threshold for either English or Arabic was excluded, leaving a subsample of 34 children, all of whom could be considered biliterate; that is, they had at least a basic level of reading proficiency in both languages. Children who scored more than 1.5 SDs below the mean in either English or Arabic were excluded. Excluding these children from the data set resulted in a more homogeneous reading ability group. The children who met the inclusion criteria comprised 24 children from the UK and 10 from the KSA. Twenty six children were female (eight male), and their mean age was 10.23; more details of the participants for each grade are presented in Table 4.1. What follows in this thesis is the analysis of data from only the selected biliterate sample.

There are differences between the education systems in the KSA and UK, including the age when children start school, the school term and reading instruction. Schooling in Saudi Arabia is run by the Ministry of Education and has several phases. From age three to five, the child goes through optional kindergarten. Primary schooling starts at age six and takes six years. Upon completion of elementary school, children go through intermediate education before joining secondary school. Both the intermediate and secondary phases are divided into three grades. A single academic year has 30–35 weeks and is divided into two terms of approximately equal duration. Pupils attend 45-minute lessons for 25–36 hours a week (Almaghidi, 2004; Ministry of Education, 2009; Saudi Arabian Cultural Mission, 2006). There were no specific reading instructions for teaching Arabic at the schools; some schools

used the phonics method, such as the private school, and some used the whole language approach, such as the international school.

The education system in the UK is run by the government as well, and school attendance is compulsory for all children aged 5–16. There are four key stages, and the programmes of study determine the learning material. In primary school, which is made up of two key stages, children are taught English, mathematics and science. In English, for example, children learn to speak and develop oral language skills by telling stories, listening attentively and demonstrating comprehension of what they see and hear. They also learn to read through novels, poetry and picture books (British Council, 2008). After six years, students are enrolled for five years in key stages 3 and 4. Each academic year has three terms, each lasting 13 weeks, with all classes in English apart from language teaching, which is rarely, if ever, Arabic.

For the monolingual participants, seventy-nine participants (36 male, 43 female) were recruited from two private schools—a boys' school and a girls' school—in Jeddah, Saudi Arabia, where Arabic was the language used for teaching (see Section 3.5 for more details). The participants for each grade are presented in Table 4.1. Private schools were chosen so that the participants were better matched for background factors with the bilingual children, who also attended private (international) schools. All the participants were aged between 8 and 12 years (M = 10.32; SD = 1.04) and were native monolingual Arabic speakers.

Table 4.1

Absolute Numbers and Percentages per Gender and Age of the Biliterate (N = 34) and Monolingual (N = 79) Participants

Characteristics	Monolingual	Biliterate
Female	43 (54%)	26 (77%)
8 years	3 (4%)	3 (9%)
9 years	14 (18%)	7 (21%)
10 years	28 (35%)	13 (38%)
11 years	23 (29%)	7 (21%)
12 years	11 (14%)	4 (12%)
UK	0	24 (71%)
KSA	79 (100%)	10 (29%)

4.2.2 Measures

Standardised Tests in English. Three standardised tests of reading and reading-related skills were administered to all participants. The tests used were the TOWRE, the DTWRP and the CTOPP in English (Table 4.2). These are described in detail in Section 3.6.2.

Adapted Tests in Arabic. Arabic versions of the TOWRE, test of word reading accuracy and test of phonological processing were created. The procedure used for adapting these tests can be found in the main methodology chapter (see Section 3.6.4).

Table 4.2

Summary of Instruments Used

Instruments	**Skills Measured**	**Time Duration**
TOWRE-2	Reading fluency	2 mins per language
DTWRP	Reading accuracy	10 mins per language
CTOPP-2	Phonological skills	35 mins per language
Home Languages Questionnaire	Exposure to the language	5 mins

Home Languages Questionnaire. An orally administered questionnaire (see Appendix 3) was used to investigate L2 learners' language exposure. More details about the questionnaires can be found in the main methodology chapter (see Section 3.6).

4.2.3 Procedure

Each child was tested individually in a quiet room at school during a single session, lasting not more than 50–55 minutes for each language. The child was given a break after finishing the CTOPP in each language. The children were also given breaks during the testing as needed. Before each task, participants were asked to choose which language they preferred to start with, English or Arabic. When presenting the adapted Arabic tests and the questionnaire to the children, the researcher applied the two forms of Arabic. She first read the information in Standard Arabic, and if the child did not understand, she explained it in local Arabic.

The tests used in this study were administered in two stages, starting with English and then Arabic or the reverse. Before administering the tests, the students were asked to complete the Home Languages Questionnaire. This was administered orally by the researcher, and the children were asked if they preferred to respond in English or Arabic. This took approximately five minutes to complete. Subsequently, the first stage involved measuring word reading proficiency using the TOWRE, the DTWRP and the CTOPP-2 in English. In the second stage, children were assessed in Arabic using the adapted assessment tests (see Section 3.6.3) of word reading efficiency, word reading accuracy and phonological processing. The tests were administered in the same order for every child and all bilingual children completed all three tests in one language before moving on to the other language. All monolingual children completed all three tests in Arabic.

4.3 Results

This section describes the analyses and presents the results. First, descriptive statistics are presented for all measures used in Study 1 in terms of means, standard deviations and ranges (Table 4.3). Second, performance in tests in Arabic and English is compared using paired *t*-tests (Table 4.4). From those analyses, a difference in performance across countries was observed and this was examined further using mixed ANOVAs. Next, compare the performance of biliterate and monolingual children in reading efficiency, reading accuracy and phonological processing skills in Arabic to answer the research question. All analyses were conducted using SPSS version 23.0 (IBM Corp., Armonk, NY) statistical software.

Composite scores were used to reduce the number of variables included in the analysis. The rationale for developing composite scores is that underlying subtests essentially measure the same construct and that construct is quantifiable in multiple ways. TOWRE, DTWRP and CTOPP all allow for such composites to be generated and these composites can also be used to derive standard scores. For instance, phonological awareness has five subtests, all of which measure an aspect of PA; these subtests measuring the same skills are combined to create a composite. The subtests were combined based on what the subtests purported to measure (i.e. top-down, not bottom up) in the following ways.

As both subtests of the TOWRE measure reading efficiency, the 108-word and 66-nonword subtests were combined to create a composite for reading efficiency, irrespective of whether it was related to words or nonwords. For the DTWRP, which measures reading accuracy, the 30 regular words and 30 nonword subtests were combined to create a composite for reading accuracy (exception word reading was not included). For the phonological processing test, the 34 elision, 33 blending words, 32 phoneme isolation, 30 blending nonwords and 31 segmenting nonwords tasks were combined to create a composite score for phonological awareness. The 28 memory for digits set and 30 nonword repetition set were combined to create a composite for phonological memory.

The rapid digit and rapid letter naming subtests were not combined to create a composite score for RAN. This was because the English and Arabic words for numbers differed in length, with Arabic number words being longer than English number words. To control for the impact of word length, digit naming time was divided by the total number of syllables in each test: the English rapid digit task was analysed by dividing the mean time of the raw score by 42, and for Arabic, the mean time of the raw score was divided by 54 (see Chapter 3, Section 3.6.4 for more details). The raw scores were used for rapid letter naming in line with the manual instructions.

First Research Question

4.3.1 How do reading and reading-related skills differ between Arabic and English in biliterate students?

First, to check for normality of reading efficiency, as well as reading accuracy and all the subtests in phonological processing, the distributions were analysed using SPSS. The results of Shapiro-Wilk's tests showed that the assumption of normality for the English test scores and Arabic test scores was satisfied for each language. Therefore, parametric tests were used.

Paired sample *t*-tests were conducted to compare students' performance in the English and Arabic reading efficiency, reading accuracy, PA, PM, RAN digits and RAN letters tests. The Bonferroni correction for multiple comparisons was used to adjust the alpha level, so the *p*-values to determine significance were adjusted to 0.05/6 = 0.008, because the total number of tests was six (reading efficiency, reading accuracy, PA, PM, rapid digit naming and rapid letter naming). Composite scores were created (see Section 1.3); the correlation matrix for creating composite scores in English is presented in Appendix 10 and for Arabic in Appendix 11. Descriptive statistics are presented for all measures used in Study 1 for the different year groups and languages in terms of means, standard deviations and ranges (Table 4.3). The correlations between the test scores show that all the within-construct variables were correlated, and these are presented in Appendix 12.

Paired sample t-tests were conducted (Table 4.4) to compare students' performance in English and Arabic reading efficiency, reading accuracy, PA, PM, RAN digits and RAN letters tests.

Table 4.3

Mean, Standard Deviation (in parentheses) and Minimum-Maximum (in square brackets) Composite Scores for the Tests of Word Reading Efficiency, Diagnostic Test of Word Reading Processes and Comprehensive Test of Phonological Processing for Children in Each Grade Level in Each Language (N = 34)

Test	N	Languages	Reading efficiency (out of 174)	Reading accuracy (out of 60)	PA (out of 160)	PM (out of 58)	RAN-L time in seconds	RAN-D seconds per syllables
Grade 3	3	English	111.67 (11.15)	54.33 (2.31)	122.0 (3.61)	36.67 (2.08)	18.67 (4.72)	.40 (.04)
			[99–120]	[53–57]	[118–125]	[35–39]	[15–24]	[.38–.45]
		Arabic	75.0 (27.07)	51.67 (1.53)	99.0 (7.55)	35.0 (1.0)	31.33 (19.65)	.79 (.02)
			[44–94]	[50–53]	[91–106]	[34–36]	[19–54]	[.78–.81]
Grade 4	7	English	116.0 (18.91)	53.14 (4.06)	129.57 (9.62)	39.43 (3.50)	17.86 (2.91)	.38 (.05)
			[90–147]	[46–57]	[113–141]	[35–46]	[14–22]	[.31–.48]
		Arabic	49.86 (11.35)	47.57 (5.83)	110.57 (3.41)	39.86 (3.53)	26.71 (9.07)	.76 (.17)
			[35–64]	[41–57]	[107–117]	[36–46]	[18–40]	[.46–.96]

Test	N	Languages	Reading efficiency (out of 174)	Reading accuracy (out of 60)	PA (out of 160)	PM (out of 58)	RAN-L time in seconds	RAN-D seconds per syllables
Grade 5	14	English	119.93 (22.26) [71–151]	52.14 (5.76) [39–59]	130.71(12.14) [101–146]	38.36 (4.68) [33–51]	17.93 (3.67) [13–28]	.35 (.07) [.24–.43]
		Arabic	71.14 (27.67) [33–120]	51.50 (6.96) [37–60]	124.64 (10.46) [100–139]	39.43 (4.39) [34–50]	23.21 (5.96) [14–34]	.62 (.28) [.20–.94]
Grade 6	10	English	119.20 (13.75) [97–138]	55.0 (3.13) [49–59]	134.30 (7.92) [121–149]	38.60 (1.65) [36–42]	16.50 (3.41) [12–21]	.36 (.06) [.29–.48]
		Arabic	66.60 (13.46) [48–86]	52.60 (6.15) [38–58]	128.90 (5.74) [120–137]	40.90 (2.56) [39–47]	22.80 (5.61) [15–31]	.62 (.22) [.30–.91]

Note. PA = Phonological Awareness, PM = Phonological Memory, RAN-D = Rapid Digit Naming, RAN-L = Rapid Letter Nam

Table 4.4

Mean, Standard Deviation (in parentheses) and t-test Composite Scores for the Tests of Word Reading Efficiency, Diagnostic Test of Word Reading Processes and Comprehensive Test of Phonological Processing for Selected Biliterate Children in Each Language

Test	English	Arabic	*t*	*p*
Reading efficiency (out of 174)	118.18 (18.05)	65.76 (22.19)	15.47	.001
Reading accuracy (out of 60)	53.38 (4.54)	51.03 (6.25)	2.24	.03
PA (out of 160)	130.76 (10.19)	120.74 (12.21)	6.31	.001
PM (out of 58)	38.50 (3.52)	39.56 (3.77)	-2.41	.02
RL time in seconds	17.56 (3.45)	24.53 (8.24)	-6.12	.001
RD seconds per syllables	.36 (.06)	.67 (.23)	-7.94	.001

Note. $N = 34$; standard deviations in parentheses. Due to the Bonferroni correction, the *p*-value should be $p < .008$ to be significant. PA = Phonological Awareness, PM = Phonological Memory, RD = Rapid Digit Naming, RL = Rapid Letter Naming.

The results (Table 4.4) demonstrate that there was a significant difference between the participants' scores for the English and Arabic reading efficiency tests. The students took a longer time to read Arabic words and nonwords than English ones. There was a significant difference in PA between English and Arabic, and performance in RAN was better in English than in Arabic for both letters and digits. However, there was no significant difference between the participants' reading accuracy and PM scores for English and Arabic.

These findings led to further investigation of whether there was an interaction between language (English and Arabic) and country (24 students in the UK and 10 in the KSA). A series of mixed ANOVAs was conducted, and the differences between countries were examined. As these analyses were exploratory, the following research question emerged.

Second Research Question

4.3.2 Did the effect of language (English vs. Arabic) differ according to whether the children were living in the KSA or the UK?

For the subsample of the biliterates, a series of mixed repeated measures ANOVAs were conducted to investigate the main effects of language (English and Arabic) and country (24 selected biliterate children in the UK and 10 selected biliterate children in the KSA) and the interaction between them for each of the constructs assessed (reading efficiency, reading accuracy and phonological skills; see Table 4.5). Levene's test of equality of variances was carried out and the assumption was met. The results are reported in Table 4.19.

Table 4.5

Mean Composite Scores for the Tests of Word Reading Efficiency (TOWRE), Diagnostic Test of Word Reading Processes (DTWRP) and Comprehensive Test of Phonological Processing (CTOPP)

Test	Country	English	Arabic
Reading efficiency (out of 174)	UK	119.50 (19.33)	61.83 (21.94)
	KSA	115.00 (14.96)	75.20 (20.91)
Reading accuracy (out of 60)	UK	53.00 (4.93)	50.46 (6.63)
	KSA	54.30 (3.47)	52.40 (5.32)
PA (out of 160)	UK	132.70 (8.35)	119.83 (11.40)
	KSA	129.96 (10.93)	122.90 (14.39)
PM (out of 85)	UK	38.50 (4.14)	39.46 (3.97)
	KSA	38.50 (1.27)	39.80 (3.42)
RL time in seconds	UK	17.37 (3.63)	25.54 (9.23)
	KSA	18.00 (3.09)	22.10 (4.68)

Test	Country	English	Arabic
RD seconds per syllables	UK	.37 (.07)	.74 (.22)
	KSA	.36 (.05)	.48 (.14)

Note. $N = 34$. PA = Phonological Awareness, PM = Phonological Memory, RD = Rapid Digit Naming, RL = Rapid Letter Naming.

Reading Efficiency Test (TOWRE)

The results of the mixed language x country ANOVA revealed that there was a significant effect of language, $F(1, 32) = 201.92$, $p < .001$, $\eta^2p = .86$. There was no significant effect of country, $F(1, 32) = .437$, $p = .51$, $\eta^2p = .01$. Additionally, there was no significant interaction between language and country, $F(1, 32) = 6.78$, $p = .01$, $\eta^2p = .17$. The Bonferroni correction should be $p < .008$ to be significant.

Reading Accuracy Test (DTWRP)

For reading accuracy, the results revealed that there was no significant effect of language, $F(1, 32) = 3.61$, $p = .07$, $\eta^2p = .10$, and no significant main effect of country, $F(1, 32) = .903$, $p = .35$, $\eta^2p = .03$. Moreover, there was no significant interaction between language and country, $F(1, 32) = .075$, $p = .79$, $\eta^2p = .002$.

Phonological Awareness Test (PA)

The performance of the children on PA tasks showed that there was no significant effect of country, $F(1, 32) = .559$, $p = .46$, $\eta^2p = .02$. However, there was a significant effect of language (English and Arabic) on phonological awareness, $F(1, 32) = 31.62$, $p < .001$, $\eta^2p = .49$, and no significant interaction between language and country, $F(1, 32) = .008$, $p = .93$, $\eta^2p = .00$.

Phonological Memory Test (PM)

There was no significant effect of language on phonological memory, $F(1, 32) = 5.36$, $p = .03$, $\eta^2p = .14$. The Bonferroni correction should be $p < .008$ to be significant. There was no significant effect of country, $F(1, 32) = .017$, $p = .89$, $\eta^2p = .001$, and no significant interaction between language and country, $F(1, 32) = .123$, $p = .73$, $\eta^2p = .004$

Rapid Letter Naming

There was a significant effect of language (English and Arabic) on rapid letter naming, with higher performance in English than Arabic, $F(1, 32) = 25.39$, $p < .001$, $\eta^2p = .44$. There was no significant effect of country, $F(1, 32) = .478$, $p = .49$, $\eta^2p = .01$, and no significant interaction between language and country, $F(1, 32) = 2.79$, $p = .10$, $\eta^2p = .08$

Rapid Digit Naming

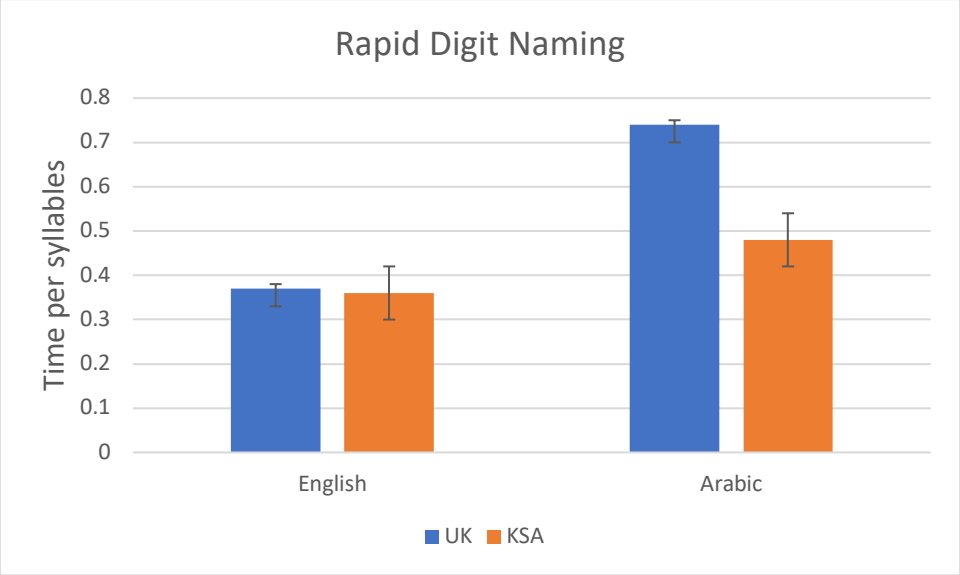
There was a significant effect of language on RAN digit naming, with higher performance in English than Arabic, $F(1, 32) = 48.35$, $p < .001$, $\eta^2p = .60$. There was also a significant effect of country, $F(1, 32) = 10.05$, $p < .003$, $\eta^2p = .24$, and a significant interaction between language and country, $F(1, 32) = 12.63$, $p < .001$, $\eta^2p = .28$.

As the interaction was significant, pairwise comparisons were conducted for rapid digit naming; the Bonferroni correction should be $p < .008$ to be significant. There was no significant difference in RAN digits in English between children in the UK and children in the KSA (*Mean Difference* = .009, 95% CI [-.04, .06]) $p = .70$, while there was a significant difference in RAN digits in Arabic between children in the UK and KSA (*Mean Difference* = .265, 95% CI [.11, .42]), $p < .001$. The children in the UK performed much better than those in the KSA.

Furthermore, in the UK, there was a significant difference between RAN digits in English ($M = .37$, 95% CI [.34, .39]) and RAN digits in Arabic ($M = .74$, 95% CI [.66, .83]), with the children performing faster in English than in Arabic, $p < .001$. However, there was no significant difference between reading digits in English and Arabic for children in the KSA (*Mean Difference* = -.12, 95% CI [-.25, .001]) $p = .05$ (see Figure 4.1).

Figure 4.1

Mean Raw Scores of Rapid Automatised Naming of Digits in English and Arabic in the UK and KSA



Note. Error bars show standard errors.

4.3.3 Findings From the Home Languages Questionnaire

As a large difference was observed between children in the UK and the KSA in terms of their reading skills, it was important to establish whether this might be explained, in part at least, by their exposure to each language. If children living in the UK are exposed to more English than their counterparts in the KSA, then it might be expected that their English reading skills would be better. Independent samples *t*-tests were conducted to compare the home language use of children in the UK and the KSA to reveal whether there was a systematic difference between them. The children were asked to indicate on a five-point Likert scale (see Appendix 3) the languages (Arabic and English) they spoke with their parents (mother and father separately), siblings and friends. Mean scores were calculated for each question.

Table 4.6

Mean Scores for Children's Responses (Comparing the UK With KSA) for Speaking in English With Their Parents, Siblings, School Friends, Having Dinner, Watching TV and Reading for Pleasure Time

Exposure to English	UK Mean (*SD*)	KSA Mean (*SD*)	*p*-value
Speaking to parents	.83 (1.23)	.45 (.49)	.35
Speaking to siblings	2.79 (1.72)	1.60 (1.51)	.07
Speaking to school friends	3.67 (.70)	2.70 (.82)	.001
Speaking to friends outside school	3.75 (.44)	3.20 (.63)	.007
Having dinner	2.50 (.83)	1.70 (.95)	.02

Note. $N = 34$ participants. Each item was based on a 5-point Likert scale where 0 indicated Never, 1 indicated Rarely, 2 indicated Some, 3 indicated Most of the time and 4 indicated All of the time.

As shown in Table 4.6, there was no significant difference between the groups regarding speaking English with their parents. Moreover, there was no significant difference when they spoke to their siblings. However, children in the KSA spoke less English to their friends at school, $t(32) = 3.48$, $p < .001$, and outside school, $t(32) = 2.90$, $p < .007$. There was a significant difference between children in the UK and those in the KSA in activities that used English, for example, when having dinner: the children in the UK spoke more English, $t(32) = 2.45$, $p < .02$.

The findings revealed that English was equally used with parents in the UK and KSA, and with siblings. The children in the KSA spoke less English with their friends at school and outside school and when having dinner than those in the UK.

In summary, the comparison between Arabic and English for the biliterate children revealed that there was a significant difference between participants' reading efficiency, PA and RAN (letters and digits), and children performed better in English than Arabic. However,

there was no significant difference between participants' reading accuracy and PM scores for English and Arabic

The mixed repeated measures ANOVAs result revealed that there was a significant effect of language on reading efficiency, PA and rapid letter naming, in which children performed better in English than Arabic, while there was no significant effect of language and countries on reading accuracy and PM. Finally, in rapid digit naming, there were significant effects of language and country on RAN digits; the selected biliterate children in the UK performed better than those in the KSA in the English language, and there was a significant interaction between language and country.

The finding that biliterate children performed poorly in Arabic reading efficiency skills, PA and RAN (letters and digits) in the KSA compared to biliterate children learning Arabic in the UK, despite Arabic being a transparent language and all the participants being native Arabic speakers, led to further investigation of the reasons for this. The question was raised as to whether it was due to the lack of exposure to Arabic, as monolingual Arabic-speaking children who are educated in Arabic only have much higher exposure to Arabic (both the language and in terms of reading instruction) and so should perform better on Arabic tests than bilinguals if the issue is related to exposure. Alternatively, there may be differences in reading instruction or specific difficulties associated with learning to read in Arabic. The next research question was posed to understand why the children in Saudi Arabia did poorly in Arabic and why there were substantial differences between languages (Arabic–English) and between countries (UK–KSA).

The objective of these analyses was to compare the performance of the biliterate and monolingual children in reading efficiency, reading accuracy and phonological processing skills in Arabic to answer the research questions. The data were analysed using SPSS 23.0 version (IBM Corp, Armonk, NY) statistical software.

The data for the descriptive statistics of each subtest for the biliterate 34 children and monolingual children in the KSA are presented in Table 4.7 (minimum scores, maximum scores, means and standard deviations). These were used to understand the outcome variables: reading efficiency (words and nonwords), reading accuracy (nonwords and regular words), phonological awareness (elision, blending words, phoneme isolation, blending nonwords and segmenting nonwords), RAN (rapid digits and rapid letters) and phonological memory (memory for digits and nonword repetition).

Table 4.7

Summary of the Raw Scores Minimum and Maximum, Mean (SDs in Parentheses) in Reading Efficiency, Reading Accuracy and Phonological Processing Skills (PA, PM & RAN) Tests for Biliterate and Monolingual Children

Tests	Group	Min score	Max score	Mean (*SD*)
Reading efficiency				
Word reading (raw score, out of 108)	Biliterate	17	87	39.44 (16.08)
	Monolingual	18	74	49.28 (14.51)
Nonword reading (raw score, out of 66)	Biliterate	9	44	26.32 (7.67)
	Monolingual	12	47	31.18 (8.39)
Reading accuracy				
Nonwords (raw score, out of 30)	Biliterate	10	30	24.65 (4.54)
	Monolingual	4	30	27.05 (4.81)
Regular words (raw score, out of 30)	Biliterate	21	30	26.38 (2.51)
	Monolingual	12	30	27.77 (3.68)
Phonological Awareness (PA)				
Elision (raw score, out of 34)	Biliterate	16	30	25.97 (3.59)
	Monolingual	17	32	29.77 (2.05)
Blending words (raw score, out of 33)	Biliterate	20	30	25.06 (3.20)
	Monolingual	25	32	29.41 (1.43)

Tests	Group	Min score	Max score	Mean (*SD)*
Phoneme isolation (raw score, out of 32)	Biliterate	19	29	25.09 (2.47)
	Monolingual	15	32	28.76 (2.42)
Blending nonwords (raw score, out of 30)	Biliterate	19	26	22.91 (2.12)
	Monolingual	18	29	28.00 (1.70)
Segmenting nonwords (raw score, out of 31)	Biliterate	15	28	21.71 (3.01)
	Monolingual	16	30	27.15 (2.32)
<u>Phonological Memory (PM)</u>				
Memory for digits (raw score, out of 28)	Biliterate	14	26	17.82 (2.82)
	Monolingual	11	22	15.28 (1.70)
Nonword repetition (raw score, out of 30)	Biliterate	19	29	21.74 (2.11)
	Monolingual	11	30	26.51 (2.40)
<u>Rapid Naming (RAN)</u>				
Rapid digit naming (seconds per syllables)	Biliterate	.20	.96	.67 (.23)
	Monolingual	.24	.81	21.30 (5.19)
Rapid letter naming (raw score time in seconds)	Biliterate	14	54	24.53 (8.24)
	Monolingual	13	43	21.30 (5.19)

Note. Biliterate $N = 34$, Monolingual $N = 79$

The results indicate that the monolingual children obtained higher scores than the biliterate children in the reading efficiency subtests, PA, nonword repetition, rapid letter and rapid digit naming. However, for memory for digits, the biliterate children obtained higher scores than the monolingual children, while they performed similarly in reading accuracy.

Third Research Question

4.3.4 Do biliterate and monolingual Arabic children differ in measures of Arabic word and nonword reading accuracy and efficiency and phonological processing skills?

To justify the creation of composite scores for the key constructs, Pearson's correlations were computed between individual subtest scores to determine whether all the variables associated with the constructs under investigation were significantly correlated for both monolingual and biliterate children (see Table 4.8). There was a significant correlation between the reading efficiency subtests (words and nonwords), a significant correlation between the reading accuracy subtests (nonwords and regular words), and a significant correlation between the phonological awareness subtests (elision, blending words, phoneme isolation, blending nonwords and segmenting nonwords). There was a significant negative correlation between memory for digits and nonword repetition (the two tasks within the phonological memory subtest). Therefore, a composite score was created for each of the constructs by summing the raw scores of the Arabic subtests: one for reading efficiency by combining word and nonword reading; one for reading accuracy by combining nonwords and regular words; one for phonological awareness by combining elision, blending words, phoneme isolation, blending nonwords and segmenting nonwords; and one for phonological memory by combining memory for digits and nonword repetition. This meant that four composites were created: reading efficiency, reading accuracy, phonological awareness and phonological memory (see Appendix 13). RAN digits and RAN letters were separate variables, as described in the methodology chapter (Section 3.7.3.1) and RAN digits were calculated separately from RAN letters. The Bonferroni correction for multiple comparisons was used to adjust the alpha level, so the p-values to determine significance were adjusted to $0.05/6 = 0.008$, because the total number of tests was six (reading efficiency, reading accuracy, PA, PM, RAN digits and RAN letters).

Table 4.8

Pearson's Correlations for All Arabic Reading Efficiency, Reading Accuracy, PA, PM and RAN Subtests (N = 113)

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RAN-L	RAN-D
SWE	1	.81**	.53**	.54**	.42**	.44**	.52**	.47**	.49**	.04	.39**	-.57**	-.57**
PDE		1	.64**	.59**	.42**	.42**	.52**	.48**	.47**	.09	.42**	-.46**	-.47**
NA			1	.78**	.56**	.46**	.64**	.52**	.52**	.00	.52**	-.34**	-.31**
RA				1	.49**	.37**	.69**	.50**	.56**	.02	.52**	-.32**	-.37**
EL					1	.82**	.72**	.71**	.76**	-.21*	.69**	-.31**	-.48**
BW						1	.69**	.73**	.81**	-.30**	.67**	-.31**	-.59**
PI							1	.76**	.79**	-.07	.68**	-.38**	-.64**
BN								1	.89**	-.25**	.83**	-.37**	-.67**
SN									1	-.15	.76**	-.43**	-.69**
MD										1	-.29**	-.16	.21*
NWR											1	-.27**	-.51**
RAN-L												1	.46**
RAN-D													1

** Correlation is significant at the .001 level, * Correlation is significant at the .05 level. *N* = 113. SWE = Sight Word Efficiency, PDE = Phonemic Decoding Efficiency, NA = Nonwords Accuracy, RA = Regular Words Accuracy, EL = Elision, BW = Blending Words, PI =

Phoneme Isolation, BN = Blending Nonwords, SN = Segmenting Nonwords, MD = Memory for Digits, NWR = Nonword Repetition, RAN-D = Rapid Digit Naming, RAN-L = Rapid Letter Naming.

The comparison between biliterate and monolingual children, was applied in this research question. The difference between groups was compared with a one-way analysis of covariance (ANCOVA) on the dependent variable (reading efficiency, reading accuracy, PA, PM and RAN) while statistically controlling the covariate (age in months).

Reading Efficiency Test

There was a statistically significant difference between the biliterate and monolingual groups in reading efficiency, $F(2, 110) = 9.06$, $p < .001$, partial $\eta 2 = .14$, indicating that the monolinguals read the words and nonwords significantly faster ($M = 80.54$, $SE = 2.42$) than the biliterate children ($M = 65.56$, $SE = 3.69$), after taking into account the effect of age, the covariate, which was significant, $F(1, 110) = 7.04$, $p < .008$.

Reading Accuracy Test

The difference between the biliterate and monolingual groups in reading accuracy was not significant, $F(2, 110) = 3.066$, $p < .05$, partial $\eta 2 = .05$ (with the Bonferroni correction, the p-value should be $p < .008$ to be significant), after taking into account the effect of age, the covariate, which was not significant, $F(1, 110) = .307$, $p = .58$.

Phonological Awareness

In the tests of phonological awareness, the difference between the biliterate and the monolingual children on the composite measure of PA was significant, $F(2,110) = 84.82$, $p < .001$, partial $\eta 2 = .61$, indicating that the monolinguals were significantly better in PA skills ($M = 143.15$, $SE = 1.00$) than the biliterate children ($M = 120.59$, $SE = 1.53$), after taking into account the effect of age, the covariate, which was significant, $F(1,110) = 19.48$, $p < .001$.

Phonological Memory

The difference between the biliterate and the monolingual children was significant, $F(2, 110) = 6.88$, $p < .002$, partial $\eta 2 = .11$, indicating that the monolinguals were significantly better in the PM skills ($M = 42.13$, $SE = .48$) than the biliterate children ($M = 39.52$, $SE = .74$). After taking into account the effect of age, the covariate was not significant, $F(1, 110) = 5.318$, $p = .02$.

RAN Tests

A composite for RAN was not possible to create because there were differences in calculating RAN letters and RAN digits (more details can be found in Section 3.7.3.1); therefore, each one was analysed separately. For **RAN letters**, taking into account the effect of age, the covariate was significant, $F(1, 110) = 22.96$, $p < .001$. The difference between the biliterate and monolingual groups on the RAN letters was statistically significant, $F(2, 110) =$

15.26, $p < .001$, partial $\eta 2 = .22$, indicating that the monolinguals read the letters significantly faster ($M = 21.26$, $SE = .64$) than the biliterate children ($M = 24.63$, $SE = .98$).

For the **RAN digits**, the difference between the biliterate and monolingual groups was statistically significant, $F(2, 110) = 80.85$, $p < .001$, partial $\eta 2 = .59$, indicating that the monolinguals read the digits significantly faster ($M = .34$, $SE = .02$) than the biliterate children ($M = .67$, $SE = .02$). After taking into account the effect of age, the covariate was significant, $F(1, 110) = 26.056$, $p < .001$.

The monolingual students were more efficient word readers than the biliterate children. They also showed better phonological awareness, phonological memory and rapid naming of digits and letters. However, there was no significant difference in reading accuracy between the monolinguals and biliterates.

The results of a comparison between monolingual children and biliterate children revealed that monolingual children outperformed the biliterate children on reading efficiency tests, PA, PM and RAN (digits and letters), while there were no significant differences in reading accuracy tests.

Fourth Research Question

4.3.5 Do different aspects of phonological processing ability predict reading efficiency and reading accuracy in monolingual students in Arabic?

a. Reading efficiency

To address the research question about predicting reading for monolingual children, composite scores for reading efficiency, reading accuracy and PA were created (see Table 4.9). There was no significant correlation between memory for digits and nonword repetition; hence, no composite for PM could be created (the two tasks within the phonological memory subtest): $r(79) = .00$, $p = .99$. As explained previously, RAN digits are calculated differently than RAN letters; hence, a composite for RAN was not created, and RAN letters and RAN digits were included in the analysis as individual variables. There were two simultaneous regression analyses, one with reading efficiency as the outcome variable and the other with reading accuracy as the outcome variable. In both, the predictor variables were Arabic PA, MD, NWR, RAN letters and RAN digits.

Table 4.9

Pearson Correlations for Monolingual Children for Arabic Reading Efficiency, Reading Accuracy, PA, PM and RAN Subtests (N) = 79

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RL	RD
SWE	1	.84**	.50**	.50**	.44**	.37**	.47**	.46**	.47**	.27*	.37**	-.61**	-.59**
PDE		1	.62**	.57**	.46**	.40**	.54**	.53**	.50**	.27*	.42**	-.51**	-.52**
NA			1	.85**	.64**	.49**	.78**	.73**	.66**	.05	.67**	-.35**	-.35**
RA				1	.71**	.45**	.84**	.73**	.73**	.15	.69**	-.36**	-.34**
EL					1	.66**	.66**	.52**	.55**	-.08	.75**	-.16	-.22
BW						1	.53**	.32**	.54**	-.03	.51**	-.25*	-.17
PI							1	.68**	.70**	.20	.58**	-.35**	-.38**
BN								1	.80**	.19	.70**	-.39**	-.36**
SN									1	.30**	.65**	-.51**	-.36**
MD										1	-.16	-.40	-.32**
NWR											1	-.16	-.18
RD												1	.64**
RL													1

** Correlation is significant at the .001 level, * Correlation is significant at the .05 level. SWE = Sight Word Efficiency, PDE = Phonemic Decoding Efficiency, NA = Nonwords Accuracy, RA = Regular Words Accuracy, EL = Elision, BW = Blending Words, PI = Phoneme Isolation, BN = Blending Nonwords, SN = Segmenting Nonwords, MD = Memory for Digits, NWR = Nonword Repetition = Rapid Digit Naming, RL = Rapid Letter Naming.

Simultaneous multiple regression was performed with reading efficiency as the outcome variable and PA, MD, NWR, RAN letters and RAN digits as predictor variables. The regression equation was significant, $F(5, 73) = 17.67$, $p < .001$, with an R^2 value suggesting that 54.8% of the variance in Arabic reading efficiency scores was attributable to Arabic phonological processing skills. With all variables included in the model, phonological awareness and RAN digits were significant independent predictors of reading efficiency in Arabic. The results are summarised in Table 4.10.

Table 4.10

Summary of Standard Multiple Regression Analysis for Phonological Processing Ability Predicting Reading Efficiency in Arabic

	B	*SE B*	*β*	*t*	*Sig*
PA	1.12	.26	.42	4.27	.001
MD	.48	1.04	.04	.46	.65
NWR	-.59	.49	-.11	-1.21	.23
RAN letters	-.98	.47	-.23	-2.06	.04
RAN digits	-65.17	23.51	-.29	-2.77	.007
	$R^2 = .548$**				

Note. ** $p < .001$. $N = 79$. PA = Phonological Awareness, MD = Memory for Digits, NWR = Nonword Repetition = Rapid Digit Naming, RL = Rapid Letter Naming.

b. Reading accuracy

Simultaneous multiple regression was performed with reading accuracy as the outcome variable and phonological awareness, MD, NWR, RAN letters and RAN digits as predictor variables. The regression equation was significant, $F(5, 73) = 44.09$, $p < .001$, with an R^2 value indicating that 75.1% of the variance in Arabic reading accuracy scores was attributable to Arabic phonological processing skills.

As shown in Table 4.11, with all variables included in the model, only PA was a significant, distinct predictor of reading accuracy in Arabic. The results are summarised in Table 4.11.

Table 4.11

Summary of Standard Multiple Regression Analysis for Phonological Processing Ability Predicting Reading Accuracy in Arabic

	B	*SE B*	*β*	*t*	*Sig*
PA	.81	.07	.82	11.30	.001
MD	-.27	.28	-.06	-.94	.35
NWR	.09	.13	.05	.71	.48
RAN letters	-.02	.13	-.01	-.18	.85
RAN digits	-4.69	6.45	-.06	-.73	.47
	$R^2 = .751$**				

Note. ** $p < .001$. $N = 79$.

The regression analyses revealed that for the monolingual Arabic speakers, phonological awareness and RAN digits were significant predictors of word reading efficiency in Arabic. Only PA was a significant predictor of Arabic word reading accuracy.

In summary, the comparison between Arabic and English for the biliterate children revealed that there was a significant difference between participants' reading efficiency, PA and RAN (letters and digits), and children performed better in English than Arabic. However, there was no significant difference between participants' reading accuracy and PM scores for English and Arabic

The mixed repeated measures ANOVAs result revealed that there was a significant effect of language on reading efficiency, PA and rapid letter naming, in which children performed better in English than Arabic, while there was no significant effect of language and countries

on reading accuracy and PM. Finally, in rapid digit naming, there were significant effects of language and country on RAN digits; the biliterate children in the UK performed better than those in the KSA in the English language, and there was a significant interaction between language and country.

The series of ANCOVAs reported above revealed significant differences between biliterate and monolingual readers in Arabic word reading efficiency, word reading accuracy, phonological awareness, phonological memory and rapid naming, with monolingual readers being more efficient and accurate than the biliterate readers.

4.4 Discussion

This section discusses the study's main findings and their implications, relating them to previous studies in the field. The aim of this study was to examine the relationship between phonological processing and reading skills for typically developing bilingual children in Arabic–English. The goal was to inform the field on how these students perform in reading and phonological related tasks. To achieve this, a series of statistical analyses was applied.

The data were collected from different schools in the UK and Saudi Arabia and analysed quantitatively. After analysing the data for the biliterate children, the results showed large variances and some very low scores on the reading measures for the Arabic language. There were 34 biliterate children. After analysing the data for their reading accuracy, efficiency and phonological processing, the results indicated that the biliterate children performed poorly in reading efficiency and phonological processing in Arabic. However, the biliterates showed no difference between English and Arabic in reading accuracy, and on the PM measure, the biliterate children performed similarly in English and Arabic.

The researcher assessed reading accuracy, efficiency and phonological processing. The following discussion highlights the research questions for the biliterates and then comparison between biliterate and monolingual children, starting with the first research question.

Are there differences between Arabic and English in word reading (accuracy and fluency), PA, PM and RAN in biliterate Arabic–English children?

The students completed both tests in English and Arabic. The results showed that biliterate children were significantly faster at reading words and decodable nonwords in English than in Arabic. However, there were no differences in reading accuracy between the languages.

Three possible explanations for such findings exist: exposure to the language, the complexity of Arabic orthography and the lack of parity in tests across languages. The first possible explanation is that the children's English language skills were better than their Arabic because they had more exposure to English. The children who were in the UK in Arabic Saturday school (School B) had Arabic only once a week, while those in Schools A and C were taught Arabic as a subject once a day. Arabic and English were not taught equally. English was emphasised in schools and outside, while Arabic was limited to home use and selected classes in schools. Given this difference in exposure across the two languages, it might be expected that English reading would be better than Arabic reading. A child's language ability was related to the amount of their language exposure: 'more language experience results in more rapid language development' (Place & Hoff, 2011, p. 1847).

Language exposure influences linguistic development in bilingual children (Place & Hoff, 2011); for example, learning the Arabic language is not the same as learning English. When children are learning to read English, they are learning a language they already speak. On the other hand, children who are learning Arabic are first exposed to one version, which is Spoken Arabic, then encounter another version when they enter school, which is Standard Arabic (diglossia). The delay in acquiring Standard Arabic might affect the development of reading Arabic words accurately and efficiently. This finding is in line with Ayari (1996) and Al-Azraqi (2014), who stated that diglossia delays the development of reading skills in Arab children.

Such an interpretation is supported by the findings in Saigh-Haddad's studies (2003, 2005, 2007, 2018). These studies tested the effect of phonological representations on literacy development in Standard Arabic, including phonological awareness, pseudoword decoding and differences between the words in Spoken Arabic and Standard Arabic. She found that variations between the two affected the production of Standard Arabic literacy skills. It is difficult for Arabic-speaking children to produce good quality phonological representations for Standard Arabic words. In contrast to Spoken Arabic, Arabic children found it challenging to grasp phonological patterns present in Standard Arabic (Saigh-Haddad, 2003, 2005, 2007, 2018). With regard to typically developing Arabic–English bilingual children enrolled in international schools, it is most common for them to speak Arabic at home, and when they communicate with their friends and siblings or watch television, they are more likely to hear Spoken Arabic. Even at school, when the teacher speaks with the children in Arabic, they use Spoken Arabic. It is likely that the children in Study 1 discovered a gap

between Spoken and Standard Arabic and that they discovered that reading in English was superior to Arabic reading.

Another explanation lies in the visual complexity of Arabic orthography. Arabic can become transparent when letters are indicated with diacritical marks and can be opaque without diacritical marks. All the items in the Arabic versions of the current study were presented with diacritical marks to avoid ambiguity. Therefore, the visual complexity of Arabic words and nonwords (with diacritics) is greater than in English, which could be one explanation for why it took longer to read the words in Arabic. Additionally, there is a visual complexity of letter shapes and word forms. As the Arabic alphabet uses cursive script and there is more than one form for most letters, students require strong sublexical orthographic skills to read accurately (Coltheart et al., 2001; Ehri, 2014).

The results showed that the selected biliterate children were fairly near the ceiling in reading accuracy scores for the two languages; this indicates the possibility that the test was simply inappropriate for them. These results therefore need to be interpreted with caution when drawing conclusions about the reading accuracy of typical Arabic-English readers.

Since most English tests are not designed to assess bilingual children, it was important to assess them in both languages (Boerma & Blom, 2017), but it proved difficult to find standardised tests in Arabic that were equivalent to the English tests. The use of the adapted tests may have affected the results.

The difference between PA in Arabic and English showed significant differences, with both the original bilingual children and selected biliterate group performing better in English than Arabic. Children who speak languages that are distinct from one another phonologically and orthographically may need further assistance to comprehend the linguistic distinctions between their mother tongue and the other language they speak. Standard Arabic uses an alternation of consonants and vowels, which would be familiar to English speakers, but that this alternation is not used in Spoken Arabic.

For the phonological memory test, there was a significant difference between English and Arabic. The original bilingual children performed slightly better in Arabic than in English. This study's evidence for the original bilingual children suggests that PM is better in Arabic than English, as the role of PM is part of a general construction of phonological processing in terms of reading development rather than being a causal component in itself. This indicates that PM had no causal link to the reading process as the bilingual children in this study

performed better in English reading skills than Arabic. Thus, if phonological memory has an impact on reading skills, it is likelier to affect Arabic reading skills. This result suggests that phonological memory depends on phonological representations (Abu-Rabia & Siegel, 2002; Harrison et al., 2016). The issue of whether the children performed better on PM in the UK or in the KSA is discussed under the next research question. Another possibility could be that the Arabic versions of the PM tests were simply easier than the English versions, for whatever reason. However, there was no effect of language on the PM task for the selected biliterate children.

An interesting finding to emerge from the analysis is that performance on the RAN test for digits and letters was better in English than in Arabic despite controlling for the Arabic digits being longer. This result is in line with Ibrahim et al. (2002), who found that bilingual Arabic–Hebrew children recite universal digits (English digits) faster than Hindi digits (Arabic digits). A possible reason is that the bilingual children were taught mathematics in English, while only Islamic and Arabic subjects were taught in Arabic; consequently, the children were not familiar with the Arabic number words. The finding that RAN did not contribute to Arabic reading may be somewhat limited to bilingual children who have less exposure to the Arabic language in addition to their weak knowledge of the Arabic number words. The RAN task relies on the fact that participants are familiar with the stimuli to be named; it is a test of fluency, not accuracy or knowledge (Georgiou et al., 2008; Taibah & Haynes, 2011; Ziegler et al., 2010). If the children's knowledge of numbers was too poor to support their performance on this task, then it was not an appropriate measure. The children in this study knew the numbers in Arabic except for one child in Grade 5, but they took a long time to read them. Although the children were familiar with the Arabic letters, they took a long time to read the RAN letter test. This is possibly because there were similar letters, such as ت/t and ن/n, which had the same shape but differed with the dots.

The analysis of the digit syllables and phonemes in the methodology chapter (see Section 3.6.5) showed that the Arabic digit names are two to three syllables long, while the English digit names are one to two syllables long, and that Arabic had nearly twice as many syllables for the digit task. Despite the researcher controlling for this, it is less likely that this could explain the low performance in Arabic RAN because the participants spent more time reading the digits in Arabic than reading digits in English. As explained in Section 3.6.4, it is worth considering the process of adapting the RAN tests into Arabic. In the updated Arabic version,

the researcher tried to include the same number of phonemes and syllables as in the English version.

In summary, the selected biliterate children performed better in English reading skills than in Arabic, apart from reading accuracy. Possible reasons include the complexity of the Arabic language, their lower exposure to the Arabic language and the tests not being equivalent. There was a significant difference in performance on PA between English and Arabic, but performance on PM was slightly better in Arabic than in English, while performance on RAN digits and letters was far better in English, likely because the children took a long time to recognise the Arabic numbers and letters.

Another explanation for the differences between English and Arabic concerns the orthographic nature of each language. Further discussion about the differences can be found in the general discussion chapter (Section 7.6.1.3). The next section deals with the second research question for bilingual/biliterate children.

Did the effect of language (English vs. Arabic) differ according to whether the children were living in the KSA or the UK?

The second research question emerged after observing differences in performance in reading in English and Arabic between the children in the UK and those in the KSA. As the children performed better in English than in Arabic in reading efficiency, PA and RAN, it was necessary to investigate the reason for this result, which required comparing their performance between countries.

For the biliterate children, there was only a significant effect of language; the children performed better in reading efficiency in English than in Arabic. However, there was no significant effect of country. However, for reading accuracy there was no significant effect of language or country and no significant interaction between language and country.

Turning to PA, the biliterate children showed no significant effect for country and no significant interaction between language and country, but there was a significant effect of language, with English being better than Arabic. For PM, performance for the biliterate children showed no significant effect of country or language.

In RAN letters, the biliterate children showed no significant effect of country and no interaction between language and country. However, there was a significant effect of language, with English being better than Arabic.

Finally, for RAN digits, there was a significant effect of language, with English being faster than Arabic, and there was a significant effect of country; the children in the UK read the English digits faster than those in the KSA. However, there was no significant difference in RAN digits in Arabic between children in the UK and the KSA. More discussion about RAN can be found in the general discussion chapter, Section 7.3.

The results showed that for the measures of reading efficiency, the children performed better in the UK than in the KSA. This superior performance held for both languages. Although the difference between the countries was much greater for English than for Arabic, the children in the UK performed better, even in the Arabic language. The possible reasons might be related to different teaching methods or school/societal expectations across countries.

The researcher's observations and the school documents revealed that the Arabic and English teaching methods for bilingual learners in international schools differed (Al-Jarf, 2007). Children learn reading in English by using a phonics-based approach. However, they begin learning to read in Arabic through the introduction of letters in different positions within different words and diacritical marks, and then look at single whole words with pictures to learn to recognise the words. The results may reflect differences in teaching between countries (the UK children used systematic phonics instruction while the KSA children used a whole language approach). In the KSA, reading starts with recognising letters before progressing to whole words. Students are first taught to identify and match multiple forms of letters in Grade 1. Instructors in Saudi Arabia are encouraged to teach decoding by emphasising whole words, and only first graders learn decoding by pronouncing letter sounds with vowels, even though whole word reading is greatly desired. Letters are taught in distinct colours to emphasise their orthographic form (Al Ghanen & Kearns, 2014). As a result of the whole language approach that Arabic children encounter, their reading acquisition is affected. Differences in teaching methods also reflect the difference in the orthographies, as arguably, Arabic children have a lot more to learn in some ways, such as the changing shapes of letters according to the position in the word.

One possible explanation is that most of these children came to the UK with their families and lived with immigrant parents who wanted their children to learn Arabic by attending Saturday school. Consequently, they encouraged children to learn Arabic by running Arabic-based classes and activities, so the children were proud to be bilingual. Hornberger (1998) pointed out that people who practise home language literacy often work hard to learn L2 and

show general appreciation for all languages. Immigrant families are more keen to develop Arabic skills to maintain their heritage (Al-Jumaily, 2015; Alsahafi, 2019). According to Alsahafi (2019), children prefer to enhance their heritage language and use it to communicate with their family, read the Qur'an and conduct daily prayers. These children, therefore, have favourable views towards bilingualism despite their English preferences because of a broader capacity to communicate and increased self-esteem (Alsahafi, 2019). Papastefanou et al. (2019) concluded that the minority language does not affect children's development of the majority language in terms of reading skills. In the current study, it can be seen that the children in the UK performed in English better than Arabic in reading efficiency skills, PA and RAN.

Concerning the Home Languages Questionnaire, the results showed that the original bilingual children in the UK had been exposed more to the English language, which likely influenced their reading skills in English, the dominant language. It can be assumed that high exposure to the English language might lead to better outcomes in English reading skills than in Arabic reading skills. Al Zoubi (2018) observed that a student who is studying in a country where the first language is English has many opportunities for exposure to the language, and exposure plays an important role in language acquisition. Moreover, Dickinson and Tabors (2001) noted that the languages used at home and at school are linked to reading achievement. A possible reason for the results in this thesis is that the original bilingual children performed better in English reading because children in the UK had substantial exposure to the English language; therefore, they would find learning to read in English much easier than those in the KSA.

It is possible that these results in reading efficiency skills in both Arabic and English can be accounted for by the minimal exposure to Arabic outside the home for children residing in the UK. The original bilingual Arabic–English population in the UK tends to use English in the general environment in which they live and as the language of communication with their friends inside school and outside school. As a consequence of this change in the linguistic environment, children may use their L1 less in their daily lives. This could account for children having greater proficiency in English than in Arabic.

Children start learning to read English at school at the age of five in the UK, whereas they start reading at six years in the KSA, which may have affected the results. Early educational success has been found to be connected with early reading and early school entrance (Kern & Friedman, 2009). Children who begin reading at a young age are directly developing their

early skills of linking letters to sounds (Lonigan et al., 2000; Sénéchal & LeFevre, 2002; Stainthorp & Hughes, 2004). The reading results showed that the performance of the biliterate Arabic–English children in the UK was better than in the KSA and better in English than Arabic, but not on accuracy, as the biliterate children in the UK started school earlier than those in the KSA.

Children in both the UK and the KSA had been exposed more to English than Arabic during the school period. All of these factors may account for the differences observed. This led the researcher to compared to investigate why children in the KSA performed poorly in Arabic.

In this study, the fact that children were not taught phonological awareness skills directly in Arabic and that the tasks (PA) were given to them in Standard Arabic supports the idea that proficiency in a language influences phonological processing abilities. As pointed out by Carroll et al. (2003), phonological awareness tasks are distinct and contain a variety of components; hence, they require a variety of abilities.

In this international school population, Schools A and C, Arabic is the dominant language in society and English is the primary method of instruction at school. Language dominance has a direct impact on literacy-related skills. Even among the biliterate children, there was a significant effect of reading efficiency, PA and RAN letter and digit, in which children performed better in English than Arabic. The section that follows compares monolingual and biliterate children.

Do biliterate and monolingual Arabic children differ in measures of Arabic word and nonword reading accuracy and efficiency and phonological processing skills?

The monolingual children performed better in reading efficiency than the biliterate children. However, there were no significant differences in reading accuracy between the monolingual children and the biliterate children. The monolinguals slightly outperformed the biliterate children in the phonological awareness tasks and the phonological memory tasks and were much faster in RAN (digits and letters). The factors that could contribute to these results, including the amount of exposure to Arabic and the type of reading instruction they received, are discussed in the following sections.

First, there was a substantial difference in the amount of exposure to Arabic that the two groups (the biliterates and monolinguals) received in school, which is likely to have had a significant impact on their Arabic reading skills. The children in Study 1 who were in the

KSA in School C were taught Arabic as a subject once a day, so they had less exposure to Arabic than monolingual children. This difference may have resulted in the different performance between the biliterate children and monolingual children.

The results revealed that the monolinguals outperformed the biliterates in reading efficiency skills, which is inconsistent with Hussien's (2014) study. In that study, which compared bilinguals (Arabic/English) and Arabic monolinguals in spelling, oral and reading accuracy, the bilingual students performed better than their monolingual Arabic counterparts. The bilingual participants appeared to reap positive effects from learning English as a second language in their learning of Arabic. They were exposed to and maintained Arabic as their mother tongue while using English as a carrier of academic development. In the current study, the biliterate children in School C were in the same situation as Hussein's sample. Kecskes (2008) found that a positive impact of L2 could be achieved if L1 exposure was intense, continuous and carefully planned, with quality rather than quantity of exposure being important for both languages. The biliterates in Study 1 had poorer reading efficiency skills in Arabic than the monolinguals, possibly because they lacked high-quality exposure to Arabic. Further, the current result that the monolinguals performed better than the biliterates is consistent with Hoff et al.'s (2012) observation that children whose exposure to the daily language is divided into two languages will probably hear less of one language than children whose daily exposure is in one language only, unless at-home bilingualism increases the quantity of talk for small children.

To consider the possible impact of reading instruction on the pattern of results in the current study, the sample consisted of monolinguals in the KSA who attended private schools, where they received intensive Arabic education and learned to read using the phonics method. In contrast, the children in the KSA at the international school (School C) began learning Arabic using the whole language approach, which relies on memory, unlike English, which is taught using the phonics method.

According to Harris and Coltheart (1986), teaching methods can influence how children learn to read. Most scholars report that the phonics method is advantageous for learning to read (Alzyoudi, 2017; Gillon, 2000; Powell et al., 2006; Stahl & Kuhn, 1995). Despite the limited research on the applicability of phonological awareness programmes in Arabic, these findings demonstrate that phonics is the best method for teaching Arabic reading (Abedlah, 2006; Elhoweris et al., 2017; Layes, Lalonde, & Rebai, 2015; Tibi, 2005). Therefore, the teaching method of reading in Arabic may have affected the results.

Why else might the monolinguals have outperformed the biliterates? A plausible explanation lies in how they were taught to read. Al-Jarf (2007) observed that there was no clear reading instructional guide for teachers in the KSA to set and track reading development. In general, children in private schools in the KSA are taught Arabic using the phonics method, as are the children who go to Saturday school in the UK, while the biliterate children who were taught Arabic in international schools in the KSA used the whole language approach. From previous studies (Ibrahim 2013; Layes et al., 2015; Tibi, 2010), it appears that the PA training programme is more effective in improving reading skills for Arabic, despite the findings by Dallasheh-Khatib et al. (2014) that did not support the PA training programme. The results in this thesis support including the PA training programme in teaching Arabic reading, although other factors may have led to the better performance of the monolinguals.

Another possible explanation concerns the age at which the children started to learn English. A child must learn their first language well to master their second language (Cummins, 2005). Most bilingual learners in the KSA who were included in Study 1 started to receive English language instruction at school at the age of 6, but the children in the UK started at the age of 4, so their Arabic was not yet fully fluent when they started learning English. Specifically, the children in the KSA started learning English at an international school, which emphasised the English language rather than Arabic (Standard Arabic). However, this study's finding that monolinguals outperformed biliterates aligns with Cummins (1999), who indicated that during the early years of education, young children must be given clear first language instruction before formal instruction in the second language. Later, second language reading instruction draws on the child's knowledge of first language reading and promotes skill transfer.

Another possible reason for the biliterate children performing poorly in Arabic reading efficiency, PA, PM and RAN (letters and digits) is related to social desirability. Some people believe that learning a new language is an essential part of social mobility. Knowing only Arabic is thought to deprive children of many opportunities, such as studying abroad or holding professional roles in which it is essential to communicate with non-Arabic speakers. The problem may not be how children learn English but how parents and educators deal with it. For example, if a child knows English but the parents do not, this can affect their relationships and understanding of each other (Good et al., 2010). Regardless of context or age, children can easily see their home language as an impediment to their social life and

English as the only way to gain entry into the social environment of the school. The challenge is when children still think that the language they already know and that their families speak at home is the biggest obstacle to engagement, integration and social acceptance (Nzai & Boleli, 2013). They soon notice that English in the social world of schools is the only acceptable language. The message they receive is that the home language has no value, and children may feel that they have to abandon the language they speak at home if they want to be completely accepted in society (Little, 2017; Piller & Gerber, 2018). Children also begin using English almost entirely outside the home, as they are learning it in school and are using it outside of school (Fillmore, 2000). English is seen as more important and socially desirable by children, so they make a concerted effort to speak and read in English rather than Arabic.

One interesting result is that the subsample of biliterate and monolingual groups showed no significant difference in the reading accuracy measure, perhaps because performance was near the ceiling. As both groups of children were close to the ceiling on the reading accuracy test in their native language, there may not have been enough difference between the scores of the two groups to be statistically significant.

The main conclusion that can be derived from the low performance in reading efficiency, PA, PM and RAN (letters and digits) is that exposure to language, as well as the way reading is taught, may affect the development of reading skills in the biliterate children. Using two languages simultaneously during learning promotes the parallel development of bilingual children's linguistic abilities in reading. It is important to mention that the comparison of the biliterate children with the monolinguals in this research is important because it is necessary to consider the factors (exposure to language and reading instruction) that affect the efficiency of the reading and performance of the biliterate children in their mother tongue. PA plays an essential role in predicting monolingual children's reading skills in Arabic. The findings of this study demonstrate the importance of using PA as an assessment in Arabic reading acquisition.

There were large differences in RAN between the biliterate and monolingual children. It seems probable that the biliterate children were simply not exposed to Arabic numbers as frequently as English numbers and therefore found the task difficult. Arguably, bilingual education is not detrimental for reading development per se, but in this context, when one language enjoys more exposure and higher status, the other language suffers. There are contexts in which biliterate education is very successful. For Saudi educational policymakers

and authorities, these results shed light on the weakness of the teaching methods that the biliterate children in the KSA received in relation to reading efficiency.

In terms of the predictors of reading skills in Arabic, the results show that PA and RAN were significant independent predictors of reading efficiency in Arabic, while only PA was a significant distinct predictor of reading accuracy. The next chapter describes Study 2, which compares bilingual children with reading difficulties with the typically developing biliterate children investigated in Study 1.

Chapter 5 Study 2

5.1 Introduction

This chapter describes the reading and phonological abilities of children with reading difficulties (RD) in Arabic and English. Study 1 highlighted the importance of phonological processing skills in developing reading skills, and then compared monolinguals and the biliterate children. It is worth noting that research on the nature and extent of reading difficulties in bilingual children with RD in the Arabic–English language is scant. The present study aimed to identify phonological processing and the word reading difficulties and strengths of bilingual children with RD in each language and to compare their performance with that of age-matched TD biliterate children from Study 1. All the children with reading difficulties who participated in this study were restricted to those in the KSA. The next section discusses how children with reading difficulties are identified in the KSA.

5.2 Identifying Children with Reading Difficulties in the KSA

In the UK, the term 'specific learning difficulties' (SpLD) is used to identify individuals who have an average or above average IQ but problems with reading skills, such as reading fluency, speed and comprehension. In the USA and Canada, the term 'specific learning disabilities' is used to describe these individuals. In the UK, the term 'intellectual disability' indicates that an individual has a low cognitive ability or intelligence, causing their learning ability to be impaired (Bertelli et al., 2016). In the USA, children with low intelligence/cognitive abilities are referred to as 'mentally retarded', indicating that their learning ability is slow (*Diagnostic and statistical manual of mental disorders: DSM-5™, 5th ed*, 2013).

The term 'reading difficulty' was used rather than 'dyslexia' because children were referred to the researcher as having some kind of learning difficulties such as Attention Deficit Hyperactivities (ADHD), Dyscalculia or Dysgraphia, including literacy difficulties, but their difficulties were not necessarily confined to reading. Also, the researcher conducted tests that provided insight into determining the presence of a reading difficulty, but not specifically identifying dyslexia.

In the KSA, the educational system is based on the USA educational system. Consequently, the terminology used in the KSA is influenced by the USA, and dyslexia is a part of 'specific learning disabilities', and there is no difference between using the term 'learning disability' and 'learning difficulty' in the KSA; dyslexia is specifically associated with reading. In this study, the UK terminology 'reading difficulties' is used because the

research was conducted at a higher education institution in the UK. In Saudi Arabia, there is a lack of standardised testing available in Arabic to diagnose children with reading difficulties. The Ministry of Education (MoE) defines 'learning difficulties' as skill deficiencies in various subjects. In this case, children with learning difficulties usually have low-level academic achievement in some subjects, such as reading, spelling or mathematics. They do not have any other disabilities, such as autism, mental disabilities or hearing/visual impairments, but they require special education needs (SEN) support independently of that provided for other disabled students (Al-Mousa, 2010).

Children with learning difficulties in Saudi Arabia are identified and diagnosed in a manner comparable to approaches used in schools in the United States (Binbakhit, 2020). Schools in the KSA, like many schools in the United States, still use a discrepancy method to detect and diagnose pupils with learning difficulties. However, according to Elbeheri et al. (2009), ineffective identification and assessment strategies can further reduce the effectiveness of support for children, particularly those who have reading difficulties. Therefore, to provide the greatest possible support for students with RD, it is critical that appropriate assessment methods be used. Valid and effective screening tools for all ages are needed so that teachers can see how students are progressing in their reading abilities.

The absence of tools and methods to evaluate the process of learning to read affects the identification, evaluation and diagnosis of dyslexia by educational psychologists and professionals. In the KSA, Western citizens have successfully established British and American schools, so parents have the option of their children learning Arabic or being educated through the British or American school system. Children who are Arabic native speakers in Gulf Cooperation Council (GCC) countries, including the KSA, speak English as their second language. This has given rise to the identification and awareness of learning difficulties and related problems, as there is a standardised test used to diagnose reading difficulties in English, but no such test is widely available and accessible in Arabic that is specific to Saudi Arabia, as there are many dialects in the Arabic language. Therefore, English methods of assessment, which have been standardised, have been used instead. These assessments have proven to be less effective and accurate for Arab-speaking learners of English because they do not take into account cultural and educational contexts (Elbeheri et al., 2009).

Some measures of cognitive ability in English have been translated into Arabic, such as the Wechsler Intelligence Scales and Stanford-Binet tests. However, the use of Arabic

standardised tests is rare due to their unavailability or because those who are trained to administer these tests do not speak Arabic (Al Rowais et al., 2013; Elbeheri et al., 2009).

There are no officially recognised diagnostic criteria for reading difficulties in the KSA. When diagnosing a child with reading difficulties, SEN teachers are given a list of all the children in each class who are performing poorly in academic subjects compared with their peers. In the KSA, grade level exams are used to assess a child's academic achievement, each subject teacher has their own set of exams for that subject that they use to determine the child's level of attainment and then an overall assessment grade is given. If a child receives a low academic achievement, and/or if they fail their grade level exam, then the SEN teacher tests them using the exam for the grade below. The SEN teacher keeps assessing using lower grade-level exams until the child passes, and the exam they pass is considered to determine their intellectual ability, which is considered inaccurate and inappropriate. According to Al-Ahmadi (2009) and Alnaim (2015), most class teachers are unaware of the characteristics of children with reading difficulties and often refer those who they perceive as having RD (but most likely do not) to SEN teachers due to a lack of awareness and limited training (Abed & Shackelford, 2021). In a study by Humphrey and Mullins (2002), some children referred by the classroom teachers and SEN teachers were found to not have RD, and their problems were a result of poor teaching quality (Humphrey & Mullins, 2002).

The SEN teacher begins by using general methods, such as interviewing the parents and asking them questions about family history, physical health history and academic development to investigate specific learning difficulties and identify children requiring a diagnostic test. Then the SEN teacher assesses the child by using curriculum-based assessment of the grade below. However, these tests lack generalisability/comparability. Based on teachers' efforts, Frederickson and Cline (2009) identified factors causing assessment bias or mistakes, including the use of unreliable assessments, bias in test content, inappropriate application of tests and lack of qualifications of those who administer the assessment. Therefore, teachers would benefit from a standardised test of reading ability for bilingual children who speak both Arabic and English.

The diagnostic process for children with RD was not consistent across schools, as there are no standardised tests specifically for the Saudi Arabic dialect, which differs from other forms of Arabic, such as Arabic for the Egyptian dialect. Therefore, some SEN teachers prefer not to refer the child to a psychologist to do an IQ test such as the translated WISC and Stanford-Binet, but instead rely on grade level assessments.

There are additional reasons for not relying solely on standardized tests to diagnose reading difficulties that vary depending on the situation and the student. Typically, there are a few factors, including that standardized tests can be costly, and in some instances, the school may not have sufficient funds to cover these costs.

Another reason is the delay in child referrals. Standardized tests must be completed within a specific timeframe; therefore, if the school is unable to refer the child quickly enough, then the test may not be completed in time.

The availability of qualified professionals to administer the tests is also a consideration. In some instances, there may be an insufficient number of trained professionals to administer these tests, which can cause additional delays. According to Alhabib (2006), the lack of standardised diagnostic tests in Saudi Arabia is a crucial problem in identifying children with RD.

Students who meet the criteria specified by the SEN teacher through assessment of the children's grade level, as previously mentioned in this section, are eligible for an individualised education programme (IEP). The IEP is a written statement that describes the specific services and equipment needed to meet the child's needs in school. Children with learning difficulties in the KSA receive support in the resource room from the SEN teacher with the use of assistive technology. Students with specific learning difficulties learn in regular classrooms most of the time, but depending on the skills they need to improve, receive extra support; for example, if a child has difficulties in learning mathematics, they go to the SEN teacher during mathematics lessons. Despite the services offered to children with learning difficulties having improved over time and the number of these pupils increasing, there are certain disadvantages to these programmes. Diagnosing learning difficulties and developing an IEP requires a multidisciplinary team, not just an SEN teacher (Almoady et al., 2013). According to Alnaim (2016), diagnosing children with learning difficulties in the KSA is hampered by the lack of a multidisciplinary team. Consequently, some children who should be diagnosed are not.

It is difficult to determine the exact percentage of children with learning difficulties in the KSA, as no clear assessment method is available. Al-Ahmadi (2009) argued that specific learning difficulty assessments greatly depend on the teacher's skills and abilities to distinguish between specific learning difficulties and other disabilities, such as lower intellectual ability, as the tests are curriculum-based. However, teachers' awareness is

based on their experience and personal background, which creates challenges when there is a lack of experience and training in identifying and differentiating children with RD.

Most teachers do not have the appropriate or sufficient knowledge and skills to assist children with reading difficulties (Alsamiri, 2018). This means that although this study intended to focus on children with RD, the sample consisted of children with suspected learning difficulties who failed to pass curriculum-based tests and scored in the average range on their IQ test. The children were referred to the researcher of this study based on their low achievement in reading/writing and their average range on the IQ test. However, it cannot be categorically stated that these children had reading difficulties due to the constraints on the assessment process documented above.

5.3 Characteristics of Dyslexia in Different Languages

Research has found that the phonological deficit and double deficit theories (PA and RAN) can explain the underlying causes of dyslexia in English dyslexic learners (Snowling & Hulme, 1994; Wolf & Bowers, 1999). Constantinidou and Stainthorp (2009) recognised the need to measure reading accuracy, speed and phonological awareness to determine dyslexia in Greek children, similar to English children. Different orthographic systems have revealed similarities rather than differences among dyslexic children (Ziegler et al., 1993). The behaviours that appear in dyslexic readers are similar across languages, such as difficulties in reading fluency, phonological awareness and rapid automatised naming. Baluch and Tousie (2006) found that dyslexic children in Iran are slower at reading even high-frequency words and make more errors than TD children. Landerl (1997) compared children with dyslexia learning English and German and found similar deficits in reading speed, but noted that in terms of accuracy, they were more accurate reading German, which is a more consistent orthography than English. Slow reading speed is a fundamental characteristic of dyslexia in transparent reading orthographies.

Research has indicated that, particularly among readers with dyslexia, the influence of word length on decoding efficiency is stronger in transparent than opaque orthography (De Luca et al., 2002; Juphard et al., 2004; Provazza et al., 2019; Zoccolotti et al., 2005). To examine the accuracy and efficiency of word and nonword decoding, Verhoeven and Keuning (2018) utilised four different word lengths as well as phonological processing assessments for children with dyslexia and TD children in a transparent language (Dutch) from Grades 3 to 6. For those readers with dyslexia, nonwords posed more difficulty than words. To read a nonword, a reader must translate letters or letter clusters into phonemes or

larger phonological units because nonwords have no long-term lexical representation in the long-term memory since they have not been encountered before. The results demonstrated that for the dyslexic readers, difficulties were apparent for both accuracy and decoding efficiency, but more so for nonwords than for words. Children with dyslexia also had greater sensitivity to the effects of word length on reading. Dyslexic children demonstrated lower decoding efficiency than their TD counterparts for both words and nonwords across all grades. Additionally, the children with dyslexia fell behind in their phonological abilities. The authors concluded that children with dyslexia were both less accurate and less efficient in decoding nonwords than words.

The reading patterns of dyslexic children may reflect differences in the reading processes relating to opaque and transparent orthographies Ziegler and Goswami (2005), Goswami (1999) suggested that there were fewer problems experienced by learners used to more transparent orthographies, which may suggest that the difficulty of literacy for dyslexic learners is lower in the context of transparent language. Reading in a transparent language (e.g. Arabic) is different from an opaque language (e.g. English), and dyslexia occurs differently in different languages (Seymour et al., 2003; Ziegler et al., 2003). According to Bogdanowicz and Bogdanowicz (2016), the biggest issue for dyslexics is learning how to read and spell, especially in orthographically deep languages such as English. Tainturier et al. (2011) proposed that reading in transparent languages like Turkish and Greek is easier because each grapheme can be associated with a phoneme. In English, however, the links between graphemes and phonemes are inconsistent, making reading more difficult. Because of the orthographies of the languages, TD children and children with dyslexia have fewer decoding difficulties in transparent languages such as Greek, Italian and Spanish than their English-speaking peers, while fluency remains difficult for dyslexic readers, even when using transparent orthographies (de Jong & van der Leij, 2003; Landerl & Wimmer, 2008; Norton & Wolf, 2012; Peterson & Pennington, 2012; Ziegler & Goswami, 2006). Difficulties related to phonological processing, verbal memory and verbal processing speed can affect readers in transparent and opaque orthographies in different ways (Rose Review, 2009).

Accurate diagnostic assessment for dyslexia is possible with an accurate understanding of L1 characteristics and the associated dyslexic profile in the language of learning. It is beneficial for bilingual children if there are assessments available in their second language, especially if there is no standardised test in their L1 (Mortimore et al., 2012). It is important to assess children in their second language to understand where they are having difficulty,

especially if the assessment is aimed at assessing skills rather than understanding the words used in the test (Smythe et al., 2008). Phonological processing skills are considered critical for the full assessment procedure, as well as considering the orthographic features of a language together with its transparency level. Zeigler and Goswami (2005) suggested that while dyslexia manifests differently across languages, the fundamental causes of dyslexia arise from a deficiency in phonological development. According to their research, people with dyslexia have the same difficulty when it comes to phonological tasks like syllable deletion, syllable reversal, nonword repetition and RAN in all languages tested. Both PA and RAN can be impaired in children with dyslexia (Caravolas et al., 2012).

Reading difficulties are marked by difficulty in PA (Anthony & Francis, 2005; Blomert, 2006; Boets et al., 2010; Norton & Wolf, 2012). Some scholars have argued that learning to read in transparent orthography will not shield readers from having phonological difficulties in their language (Caravolas et al., 2005; Landerl et al., 2013). Dandache et al. (2014) found that Dutch-speaking dyslexic children demonstrated difficulty with phonological awareness in all grades, from kindergarten to Grade 6, compared to typically developing children. Regardless of the orthographic depth of the language, defects in phonological awareness have been found in developmental dyslexia (Vellutino et al., 2004).

Deficits in PM impair individuals' decoding and reading skills alongside PA (Wagner et al., 1999). Individuals with dyslexia are characterised by poor short-term memory in addition to their reading difficulties (Jeffries & Everatt, 2004). Gathercole and Baddeley (1990) tested nonword repetition activities to assess phonological memory and found that people who could not segment and synthesise words and were not able to keep the correct information in short-term memory could have problems with word retrieval when reading (for more details about phonological memory, see Section 2.2.3).

Researchers have observed that, like PA, RAN is an indicator of reading difficulties and that children with or at risk of reading difficulties are often predisposed to poor performance in RAN tasks (Araújo & Faísca, 2019; Araújo et al., 2015; Caravolas et al., 2012). In practice, the types of assessments used to identify dyslexia may vary by language. Children with dyslexia take longer on RAN tests than age-matched controls, regardless of the orthographic complexity of their language (McBride-Chang et al., 2011). RAN is an important predictive tool for identifying dyslexia in languages with transparent orthographic forms, such as German (Wimmer & Mayringer, 2002), Turkish (Georgiou et al., 2011) and Greek (Stampoltzis et al., 2020). One of the most important aspects of RAN is its specificity

to dyslexia, as it has been found to distinguish children with dyslexia from typically developing children (Fawcett & Nicolson, 1994) in their performance on certain tasks. It has been argued that RAN is a consistent predictor of reading across different languages (Caravolas et al., 2013).

RAN deficits in a group of dyslexic children were studied in comparison to typically developing readers in a meta-analytic review study by Araújo and Faisca (2019). They demonstrated that in any orthographic system, having dyslexia had a large impact on RAN tasks. Poor performance on RAN is a universal dyslexia symptom (Araújo & Faisca, 2019). Because reading and rapid naming are closely related cognitive processes, RAN tasks are crucial in assessing reading difficulties. English-speaking children with dyslexia are more likely to have RAN-only deficits than PM-only or PA-only deficits (Mundy & Hannant, 2020). It can be concluded that RAN is a strong predictor of dyslexia in different languages.

In summary, many features of dyslexia are common across languages (in monolinguals), although the transparency of the orthography can affect the pattern of deficits observed. Two important deficits associated with dyslexia across many languages, regardless of their orthography, are deficits in phonological awareness and rapid automatised naming. The following section illustrates how reading difficulties manifest in the Arabic language, considering the obstacles that affect how children with dyslexia perform in reading Arabic.

5.4 Reading Difficulties in Arabic

Observational research on dyslexia in Arabic speakers has highlighted the effects of diacritics and long vowel graphemes on the reading accuracy of Arabic orthography. Empirical studies have focused on orthographic transparency, the role of diacritical marks in Arabic orthography and the effects of vowels on reading accuracy (Abu Rabia, 1998, 2001; Abu Rabia & Sammour, 2013; Elbeheri, 2004; Elbeheri & Everatt, 2007).

Abu-Rabia and Rahmoun (2012) compared the Arabic reading skills of children with dyslexia with a reading age-matched group of typically developing readers, as well as a chronological age-matched group. The children with dyslexia were identified based on their reading performance on a written test and a reading list of single words in addition to their general ability tests. Their sample comprised 221 pupils in Grades 6 and 8. Reading and cognitive measurements included vowelised and un-vowelised words, and phonological, spelling, reading, orthographic, syntax and working memory skills were all assessed. The results showed that all groups read the vowelised words better than un-vowelised words.

Even the eighth grade children they performed better with vowelised words because usually, in Arabic, children read un-vowelised words after Grade 3. These results reinforce the general conclusion that TD and dyslexic readers they do better with vowelised words in terms of reading accuracy and efficiency. However, the RAN task was not included in the assessment. Both reading difficulties and orthographic deficits may stem from phonological processing deficits. Reading in Arabic with diacritics marks can benefit children with dyslexia since they provide phonological information.

Layes et al. (2014) stated that the major deficiency of dyslexia is in PA, which can affect the reading skills of children with dyslexia in Arabic. They examined the reading speed and accuracy of typically developing Arabic-speaking children with and without dyslexia. Eight-to-ten-year-old participants performed word and nonword reading and phonological awareness assessments. The findings indicated that the main deficit in the children with dyslexia was phonological awareness, which influenced their reading accuracy and speed. Students who were found to be at risk of dyslexia also showed relatively poor phonological awareness skills. The authors argued that words without diacritic marks reduced the reliance on phonological processes since children are required to use the sentence context to determine the meaning of the words. Therefore, the words without diacritic marks in Arabic were read as if they were opaque words. These results may explain why dyslexics performed poorly in Arabic word reading tasks. This is especially the case for the words that look the same but have a completely distinct meaning, for example, reading the words alm/علم without diacritics marks it could be flag/عَلَم (alam) or could be knowledge/عِلْم (elem) or could be taught/عَلَّمَ (alama); they are spelled differently in English to distinguish how they are pronounced with the diacritics but if the diacritic marks were removed they would all be pronounced as (alm).

As previously mentioned, across more transparent orthographies, such as Spanish, Greek and Italian, the most common characteristic of dyslexia is slow reading rather than inaccurate reading, while in less transparent orthographies such as English, dyslexic readers demonstrate more inaccuracies as well as slower reading (Caravolas, 2004; Marinelli et al., 2016; Ziegler & Goswami, 2005). Children with dyslexia in Arabic might have accuracy and fluency problems, since the orthographic features of Arabic affect the accuracy and fluency of reading. Some Arabic letters are the same but have different dots, such as the letters (ka/خ), (ja/ ج) and (ha/ح). Children with reading difficulties are more likely to have difficulties with phoneme awareness and letter-sound knowledge (Hulme & Snowling, 2016), especially if the

letters are connected together to form a word such as the letter "j/ج" in the word of (jmal/جَمَل) or the letter "h/ح" in the word (hmal/حَمَل), it takes more time to separate the words if they look similar to one another (Abdelhadi et al., 2011). Many words are spelled the same, but the diacritic marks differentiate them. However, if the words do not include diacritic marks, it impacts reading accuracy, since children cannot recognise and differentiate between words. They may pronounce the word out of context, as there are no other ways of distinguishing between homographs, making it more difficult to understand the context of what they are reading (Leil et al., 2014).

Predictive features of phonological impairment can vary depending on the stage of reading, according to Elbeheri and Everatt (2007). There are two types of orthography in Arabic: more transparent orthography, which uses diacritical marks, and less transparent orthography, which does not. Children frequently begin reading by utilising transparent orthography versions. The nature of written Arabic plays a crucial role in reading success. PA was found to be a vital predictor of reading proficiency across primary school grades than in preschool years (Asaad & Eviatar, 2014; Layes et al., 2015). Syllable, rhyme and alliteration awareness are included in early primary school's focus on phonological awareness, although the attention is more on phonemic awareness, especially sound blending, segmentation and manipulation (Grofčíková & Máčajová, 2021).

Limited research has investigated the double deficit hypothesis in the Arabic language. A recent study by Gharaibeh (2021) measured reading skills in Arabic-speaking children in Grade 3 with RAN deficits, PA deficits, double deficits and no deficits. The no-deficit group obtained the highest reading score, while the double deficit group had the lowest, followed by the PA deficit group and finally, the RAN deficit group. Although Arabic is a more transparent language than English when it comes to representing phonology, this study provides evidence that the double deficit hypothesis also applies to the Arabic language. Asadi et al. (2017) found that children with a double deficit in both naming speed and PA in Arabic demonstrated lower performance levels than those with only a naming speed deficit or a PA deficit.

Diglossia is another factor, in addition to vowelisation, that affects the reading of Arabic words. Schiff and Saiegh-Haddad (2017) found that diglossia presents considerable difficulty for Arabic-speaking people with reading difficulties, particularly when they are learning to read. When reading, they are speaking in a 'different language' than the one they would typically speak, meaning their reading and speaking are not parallel. These differences affect

their performance in reading fluency and accuracy (Schiff & Saiegh-Haddad, 2017). More details about diglossia in Arabic can be found in Section 2.3.1.

This study focuses on bilingual learners with reading difficulties. Although much research has investigated the causes of reading difficulties in English, much less is known about bilingual children with reading difficulties in Arabic and English, especially the extent to which learning to read in one language might affect reading in another. The following research question guided this research:

- How do reading and reading-related skills differ between bilingual children with reading difficulties (RD) and biliterate typically developing (TD) children?

5.5 Method

This study focuses on children with reading difficulties, comparing their reading performance with the subsample of TD biliterate children from Study 1. Further, a comparison was made between a subset of the RD and TD children who attended the same school.

5.5.1 Participants

Twenty-eight participants (13 male) were recruited from five international schools (C, E, F, G and H) similar to the international school C in Study 1. As all of the students with reading difficulties were from the KSA, the children shared similar environments and curricula. The aim was to recruit all the children with reading difficulties from one school; however, as there was a limited number of children with reading difficulties in the schools, more than one school was included. The children in the present study received the same international curriculum (English) as those from School C in Study 1. All five schools taught all subjects in English except for Arabic and Islamic studies, which were taught in Arabic. Children with reading difficulties received their education in mainstream classrooms, while receiving specialised instruction in the learning resource rooms as required. The teacher in the learning resources room was trained in general learning difficulties. Because resource room teaching was focused on individual or group learning strategies, the number of children enrolled in the programme could range between 20–25 students, with the SEN teacher dividing the pupils into groups of 2–5 students. Students were divided into groups according to the daily lesson plan, and the SEN teacher took into account the individual differences between groups in how to present the skills and follow them up. The SEN teacher was responsible for developing the weekly lesson plan and was responsible for 20 weekly classes, which were distributed as appropriate between literacy and mathematics according to the

pupils' requirements. Each child was assigned to three or four literacy and mathematics lessons per week, distributed according to the student's difficulty or problem. After attending the class session, they returned to their class for the remainder of the lessons (more details are provided in Section 5.1.1).

The researcher asked the SEN teacher to refer all the children who were assessed as having specific learning difficulties. Although the children had already completed an IQ test, scores were not released to the researcher, so an IQ test was included for all the children in this study. The reason for this is that a person's general intelligence is a good predictor of their academic success because it measures their overall cognitive abilities (Schrank et al., 2014). An IQ test was not administered to the children in Studies 1 and 2, which is a limitation of this thesis. Dyslexic children have deficits in phonological awareness, RAN and memory, according to the Rose definition of dyslexia (see Section 2.4).

In the KSA, IQ is a crucial criterion for determining whether a child has learning difficulties. All participants completed the Wechsler Abbreviated Scale of Intelligence (WASI-II; 2016) in English and the vocabulary and similarities subtests of the Arabic Wechsler Intelligence Tests for Children (WISC-IVARB;(Elbeheri, 2017). Only the vocabulary and similarities subtests were administered in Arabic because both the WASI-II and WISC are nonverbal, so the language in which they are administered makes no difference. WASI-II is a shortened version of the WISC and the subtests are the same. As stated in the discussion chapter, one of the limitations of Study 1 was the unavailability of an IQ test for TD children.

The total raw scores of each WASI-II subtest were first converted into scaled scores. For the Arabic WISC, only the vocabulary and similarities subtests were used; therefore, only the raw scores were converted into scaled scores. The scaled scores were categorised as follows:

A scaled score from 1–7 = weakness or below average

A scaled score from 8–12 = average

A scaled score from 13–19 = strength or above average

Table.5.1

Mean Scaled Score (1–19) for WASI-II Tests for Verbal IQ (Vocabulary and Similarities) and Non-Verbal IQ Ability (Block Design and Matrix) in English, and for WISC-IV (Vocabulary and Similarities) in Arabic Among Bilingual Children With Reading Difficulties

Tests	English scaled score (WASI-II)	Arabic scaled score (WISC-IV)
VIQ (Vocabulary)	9.46 (2.89)	9.0 (2.88)
VIQ (Similarities)	9.82 (2.52)	9.93 (1.76)
NVIQ (Block design)	11.75 (2.04)	
NVIQ (Matrix)	12.28 (3.14)	

Note. N = 28 participants; standard deviations in parentheses. VIQ = Verbal IQ, NVIQ = Non-verbal IQ.

As shown in Table 5.1, the performance of the children with reading difficulties on the IQ tests was in the average range for both VIQ and NVIQ in English and VIQ in Arabic. One limitation of this study is that the researcher did not administer the same IQ tests to the TD children to ensure that the groups were comparable in this regard; the IQ scores showed that the children's IQ was within the average range for the RD children. The following section provides more information about the characteristics of the sample.

In Study 1, there were 34 biliterate children. The comparison between these 34 TD children and the 28 RD children from Study 2 is presented in Table 5.2.

Table 5.2

Numbers and Percentages for Gender and Age of Bilingual RD Children and TD Biliterate Children

Characteristics	RD	TD
Female	15 (54%)	26 (76.5%)
Male	13 (46%)	8 (23.5%)
8 years	5 (18%)	3 (9%)
9 years	5 (18%)	7 (21%)
10 years	8 (29%)	13 (38%)
11 years	6 (21%)	7 (21%)
12 years	4 (14%)	4 (12%)

Note. TD = Typically Developing; *N* = 34 participants. RD = Reading Difficulties; *N* = 28 participants

5.5.2 Measures

Similar to Study 1, both the English and Arabic versions of the three standardised tests of reading and reading-related skills were administered to all participants after being adapted to Arabic: the TOWRE-2, the DTWRP, the CTOPP-2 and the Home Languages Questionnaire. The procedure used for adapting these tests can be found in the main methodology chapter (see Section 3.6.4). Moreover, an IQ test, the WASI-II, was administered in English. All four subtests were administered: two verbal subtests (vocabulary and similarities) and two non-verbal subtests (block design and matrix). The WISC-IVARB, translated and revised by Elbeheri (2017), was administered in Arabic using only the verbal IQ subtests (vocabulary and similarities).

Wechsler Abbreviated Scale of Intelligence (WASI-II) and Wechsler Intelligence Tests for Children (WISC-IVARB)

WASI-II was developed to examine the general intellectual functioning of individuals from 6 to 90 years of age in the USA. The WASI is based on the original Wechsler intelligence model, which splits intelligence into traditional verbal (vocabulary and

similarities) and performance (block design and matrix) indices. These four subtests from the WASI in English were employed.

The WASI verbal IQ score is included in the vocabulary and similarities tests. The vocabulary subtest is a verbal test that measures knowledge of words and the ability to express them verbally. It consists of 31 items, including three initial picture items. Examinees are required to verbally define and/or describe a word or concept, for example, the word 'shirt', which the examiner presents to them orally. The similarities subtest examines abstract thought and looks for similarities between words or concepts that do not seem identical on the surface. It consists of 24 items, including three initial picture items. Examinees are required to verbally describe the relationship between two objects or concepts, for example, green and blue, that the examiner presents to them orally.

The WASI performance IQ index is included in the block design and matrix subtests. The block design subtest assesses an individual's ability to interpret and synthesise an abstract design from coloured plastic blocks and replicate it. It consists of 13 tasks during which two-dimensional red-and-white geometric designs are presented in the Stimulus Book. The tasks assess spatial visualisation and analysis, simultaneous processing, control of visual-motor skills, flexibility and non-verbal idea creation. Examinees attempt to recreate each design using the tops of the cubes. Differential start points are indicated for examinees aged 6 to 8 years and 9 to 90 years. Examiners provide examples at the beginning only, in addition to the picture in the Stimulus Book, and each item has a specified time limit.

The matrix test is an untimed subtest consisting of 30 visually depicted incomplete matrices presented in the Stimulus Book that measure visual and abstract processing and spatial perception. Performance can be affected by concentration, attention and persistence. Examinees view each incomplete matrix and are required to choose one item from a selection of five that correctly completes the matrix.

The WASI-II is a shortened version of the WISC and the subtests share the same concept, so the WISC is similar to the WASI-II. As there was no Arabic version of the WASI, the WISC was used. The only differences between them are that the similarities subtest consists of 23 items instead of 24, and the vocabulary subtest consists of 36 items instead of 31. The researcher followed the same procedure that was used in the WASI but with Arabic instruction.

5.5.3 Reliability of WASI-II and WISC-IV

The test–retest stability of WASI-II was obtained from the manual using Pearson's product–moment correlation by administering the measure twice within a 12- to 88-day interval to 215 participants in four age categories (6–11, 12–16, 17–54 and 55–90). Overall results for the child sample indicated acceptable (.79) to excellent (.90) stability coefficients for the subtests and good (.87) to excellent (.95) coefficients for the composites (WASI-II, 2016).

From the manual book of the WISC-IV, using a sample of 100 native Arabic children from 6-16 age groups with a similar ratio of males to females, the fourth edition WISC-IV scale was administered to the participants twice, and the intervals between testing and retesting ranged from 62 to 136 days, with an average of 87 days. The test–retest reliability was calculated for the four age groups (6–7, 8–9, 10–12 and 13–16). The standard difference was calculated using the difference in the mean scores between the first and second applications of the test divided by the pooled standard deviation. The mean retest scores for all subtests were higher than the mean test scores from the first administration, with effect sizes ranging from .01 (vocabulary) to .27 (symbol search). In general, the test–retest gains were less pronounced for the verbal subtests than for the other subtests. Therefore, the WISC-IV scale's fourth edition scores demonstrated sufficient stability over time for all four age groups (WISC-IV, 2017).

5.5.4 Procedure

Each child in Study 2 was assessed individually by the researcher in a quiet room at school over two sessions. For the first session, which lasted for no longer than 75–80 minutes, they had two breaks: the first one after they finished the IQ test and the second after they finished the CTOPP test. Each child was assessed in English using the standardised TOWRE-2, the DTWRP, the CTOPP-2 and the VIQ and NVIQ tests (WASI-II). For the second session, which lasted 60-65 minutes and took place the next day, the children were assessed in Arabic using the adapted tests of word reading efficiency, word reading accuracy and phonological processing and the VIQ tests, and again, they were given two breaks. This was particularly important because of the children's reading difficulties. The children were asked some questions about their home language environment and when they used English and Arabic (more details about the orally administered questionnaire, as well as the English and Arabic tests of reading and phonological processing, can be found in Chapter 3, Section 3.6.3). For the Arabic tests, while presenting the adapted Arabic and the questionnaire with the children,

the researcher used two forms of Arabic, first reading the material orally in Standard Arabic and then, if the child did not understand, explaining it in local Arabic.

5.6 Results

5.6.1 Comparison of RD and Selected TD Students Across Schools

The objective of these analyses was to compare the performance of bilingual RD children with selected biliterate children (34 children from Study 1) in word reading efficiency, word reading accuracy and phonological processing skills. All analyses were conducted using SPSS 23.0 version (IBM Corp, Armonk, NY) statistical software.

Table 5.3

Summary of the English and Arabic Raw Scores Minimum and Maximum, Mean (SDs in Parentheses) in Reading Efficiency, Reading Accuracy and Phonological Processing Skills (PA, PM, RAN Letters & RAN Digits) Tests for RD and TD Children

Tests	Group	Min score	Max score	Mean (*SD*)
Reading efficiency				
English word reading (raw score, out of 108)	RD	4	62	26.00 (14.94)
	TD	51	108	72.38 (11.95)
English nonword reading (raw score, out of 66)	RD	3	35	15.21 (8.92)
	TD	20	58	45.79 (8.49)
Arabic word reading (raw score, out of 108)	RD	2	46	20.07 (12.13)
	TD	17	87	39.44 (16.08)
Arabic nonword reading (raw score, out of 66)	RD	4	38	15.46 (8.70)
	TD	9	44	26.32 (7.67)

Tests	Group	Min score	Max score	Mean (*SD)*
Reading accuracy				
English nonwords (raw score, out of 30)	RD	4	28	14.04 (7.27)
	TD	17	30	25.50 (3.49)
English regular words (raw score, out of 30)	RD	3	26	13.75 (7.39)
	TD	20	30	27.91 (1.93)
Arabic nonwords (raw score, out of 30)	RD	4	29	15.89 (7.99)
	TD	10	30	24.65 (4.54)
Arabic regular words (raw score, out of 30)	RD	5	29	15.11 (7.19)
	TD	21	30	26.38 (2.51)
Phonological Awareness (PA)				
English elision (raw score, out of 34)	RD	3	28	17.04 (6.73)
	TD	17	33	29.38 (2.98)
English blending words (raw score, out of 33)	RD	5	28	17.89 (6.37)
	TD	20	32	27.35 (2.62)
English phoneme isolation (raw score, out of 32)	RD	4	26	16.32 (6.01)
	TD	21	31	26.24 (2.40)

Tests	Group	Min score	Max score	Mean (*SD*)
English blending nonwords (raw score, out of 30)	RD	3	26	16.11 (5.59)
	TD	17	28	23.53 (2.79)
English segmenting nonwords (raw score, out of 31)	RD	7	26	14.82 (5.32)
	TD	19	29	24.26 (2.85)
Arabic elision (raw score, out of 34)	RD	3	27	16.43 (6.21)
	TD	16	30	25.97 (3.59)
Arabic blending words (raw score, out of 30)	RD	3	28	19.29 (5.53)
	TD	20	30	25.06 (3.20)
Arabic phoneme isolation (raw score, out of 32)	RD	7	26	17.96 (5.64)
	TD	19	29	25.09 (2.47)
Arabic blending nonwords (raw score, out of 30)	RD	4	26	17.07 (5.96)
	TD	19	26	22.91 (2.12)
Arabic segmenting nonwords (raw score, out of 31)	RD	5	24	14.68 (5.06)
	TD	15	28	21.71 (3.01)
<u>Phonological Memory (PM)</u>				
English memory for digits (raw score, out of 28)	RD	7	19	12.57 (3.39)
	TD	13	26	17.97 (2.63)

Tests	Group	Min score	Max score	Mean (*SD)*
English nonword repetition (raw score, out of 30)	RD	9	20	14.36 (3.23)
	TD	18	25	20.53 (1.62)
Arabic memory for digits (raw score, out of 28)	RD	9	18	12.25 (2.59)
	TD	14	26	17.82 (2.70)
Arabic nonword repetition (raw score, out of 30)	RD	6	22	14.89 (3.44)
	TD	19	29	21.74 (2.11)
<u>Rapid Naming (RAN)</u>				
English rapid digit naming (raw score by seconds per syllables)	RD	.26	1.48	0.69 (.35)
	TD	.24	.48	0.35 (.06)
English rapid letter naming (raw score time in seconds)	RD	19	60	32.71 (11.89)
	TD	12	28	17.56 (3.45)
Arabic rapid digit naming (raw score by seconds per syllables)	RD	.31	1.57	0.60 (.27)
	TD	.20	.96	0.64 (.24)
Arabic rapid letter naming (raw score time in seconds)	RD	19	60	32.50 (10.75)
	TD	14	54	24.53 (8.24)

Note. Standard deviations in parentheses. TD = Typically Developing Children (selected biliterate children); *N* = 34 participants. RD = Reading Difficulties; *N* = 28 participants.

The results specify that the TD biliterate children obtained greater scores than the RD children in the reading efficiency, reading accuracy, PA, PM, rapid letter and rapid digit subtests in both English and Arabic. The following section compares RD children with selected TD children within the same schools.

5.6.2 Comparison of RD and TD Students Attending the Same School in the KSA

This section focuses on children within the same school (School C). Eight of the RD students attended the same school as one group of TD children in Study 1 (School C), and the data from the two groups were compared. These groups have been 'selected' by the teachers within the same school. Therefore, comparing between the groups increases the likelihood that the same curriculum measures were used to identify those with reading difficulties. The *t*-test results for all the comparisons are presented in Table 5.3 for English tests and Table 5.4 for Arabic tests. As expected, the RD group performed worse on reading measures. Their scores were also significantly lower on English PA, PM, RAN letters and RAN digits, and their performance was poor on Arabic PA and PM compared with the TD children. However, there was no significant difference in Arabic rapid digit naming, $t(16) = 1.33$, $p = .20$. There were also no significant differences in Arabic letter naming, $t(16) = 2.95$, $p = 009$. The *p*-values to determine significance were adjusted to 0.05/6 = 0.008 and compared to the calculated *p*-values.

Table 5.4

Mean (and SD) Composite Scores for the English TOWRE, DTWRP and CTOPP for the RD and TD Children

Test	Group	English	*t*	*p*
Reading efficiency	RD	20.0 (10.14)	-15.32	.001
(out of 174)	TD	115.00		
		(14.96)		
Reading accuracy	RD	12.63 (2.92)	-27.12	.001
(out of 60)	TD	54.30 (3.47)		
PA (out of 157)	RD	62.0 (18.08)	-11.04	.001
	TD	132.70 (8.35)		

Test	Group	English	*t*	*p*
PM (out of 58)	RD	22.75 (3.61)	-12.90	.001
	TD	38.50 (1.27)		
RAN-D (seconds per syllables)	RD	.89 (.40)	4.16	.001
	TD	.36 (.04)		
RAN-L (time in seconds)	RD	40.0 (12.68)	5.33	.001
	TD	18.00 (3.09)		

Note. Standard deviations in parentheses. TD = Typically Developing; *n* = 10 participants. RD = Reading Difficulties; *n* = 8 participants. PA = Phonological Awareness, PM = Phonological Memory, RAN-D = Rapid Digit Naming, RAN-L = Rapid Letter Naming.

Table 5.4

Mean (and SD), t-tests and p-values for Composite Scores for Arabic Tests of Word Reading Efficiency, Diagnostic Test of Word Reading Processes and Comprehensive Test of Phonological Processing for RD and TD Children

Test	Group	Arabic	*t*	*p*
Reading efficiency (out of 174)	RD	27.88 (15.07)	-5.37	.001
	TD	75.20 (20.91)		
Reading accuracy (out of 60)	RD	19.00 (6.87)	-11.65	.001
	TD	52.40 (5.32)		
PA (out of 157)	RD	70.63 (19.20)	-6.61	.001
	TD	122.90 (14.39)		
PM (out of 58)	RD	24.25 (4.17)	-8.70	.001
	TD	39.80 (3.42)		
RAN-D (seconds per syllables)	RD	.59 (.24)	1.33	.20
	TD	.48 (.14)		

Test	Group	Arabic	*t*	*p*
RAN-L (time in seconds)	RD	36.0 (14.05)	2.95	.009
	TD	22.10 (4.68)		

Note. Standard deviations in parentheses. TD = Typically Developing; *n* = 10 participants. RD = Reading Difficulties; *n* = 8 participants. PA = Phonological Awareness, PM = Phonological Memory, RAN-D = Rapid Digit Naming, RAN-L = Rapid Letter Naming.

In summary, the RD children performed more poorly in reading efficiency, reading accuracy, PA and PM in both languages, as well as in English rapid letter naming and rapid digit naming than the TD group, although there were no significant differences between the TD and RD groups in the respective Arabic naming tasks.

5.6.3 Research Question

5.6.3.1 How Do Reading and Reading-related Skills Differ Between Bilingual Children With Reading Difficulties and Biliterate TD Children?

A series of mixed repeated measures ANOVAs were conducted to investigate the main effects of language (English and Arabic) and group (28 bilingual children with reading difficulties and 34 biliterate typical developing children) and the interaction between them for each of the tests administered (reading efficiency, reading accuracy, PA, PM and RAN; see Table 6.3 for descriptive statistics). The first step was to create composites for the core constructs, and to do this, the researcher ran correlations between individual subtest scores. Pearson's correlations were only computed for the RD group because the researcher had already computed correlations for the TD group in Study 1 (see Appendix 10–11).

The results showed that there was a significant positive correlation between word and nonword reading efficiency scores in English, justifying the creation of a word reading efficiency measure. There were also significant positive correlations between scores on nonword and regular word reading accuracy in English. Further, significant positive correlations were found between scores on the elision, blending words, phoneme isolation, blending nonwords and segmenting nonwords tasks (all within the phonological awareness subtest). There were strong positive correlations between scores on memory for digits and nonword repetition (the two tasks within the phonological memory subtest). However, it was difficult to combine the rapid digit naming and letter naming variables (for more details, see Section 3.6.4), so a composite score for rapid naming could not be created. This meant that

four composites were created by summing the raw scores of the subtests to derive composite measures of the following constructs in English: word reading efficiency, word reading accuracy, phonological awareness and phonological memory (see Appendix 14).

For the Arabic versions of the reading and phonological processing tests, there were significant positive correlations between word and nonword reading efficiency scores, nonword and regular word reading accuracy scores, and between the elision, blending words, phoneme isolation, blending nonwords and segmenting nonwords tasks to allow the creation of a composite of PA. There were positive correlations between memory for digits and nonword repetition to allow for the creation of a composite of PM (see Appendix 14).

The researcher computed the composite variables by summing the raw scores to create each composite, as in Studies 1 and 2. The results are reported below. The correlations between the test scores show that all the variables were correlated, as presented in Appendix 15. In all analyses, a Bonferroni correction was used, so the *p*-values to determine significance were adjusted to .05/6 = .008, because the total number of tests was six (reading efficiency, reading accuracy, PA, PM, rapid digit naming and rapid letter naming). They were then compared to the calculated *p*-values. The results of the ANOVAs for each task are presented in subsequent sections.

Table 5.5

Mean (and SD) Composite Scores for the Tests of Word Reading Efficiency, Diagnostic Test of Word Reading Processes and Comprehensive Test of Phonological Processing

Test	Group	English	Arabic
Reading efficiency	RD	41.21 (23.20)	35.54 (19.23)
(out of 174)	TD	118.18 (18.05)	65.76 (22.19)
Reading accuracy	RD	27.79 (14.17)	31.00 (14.17)
(out of 60)	TD	53.38 (4.54)	51.03 (6.25)
PA (out of 157)	RD	82.18 (27.69)	85.43 (26.14)
	TD	130.76 (10.19)	120.74 (12.21)

Test	Group	English	Arabic
PM (out of 58)	RD	26.93 (6.0)	27.14 (5.08)
	TD	38.50 (3.52)	39.56 (3.77)
RAN-D (raw score seconds per syllables)	RD	.69 (.35)	.60 (.27)
	TD	.36 (.06)	.67 (.23)
RAN-L (raw score time in seconds)	RD	32.71 (11.89)	32.50 (10.75)
	TD	17.56 (3.45)	24.53 (8.24)

Note. Standard deviations in parentheses. TD = Typically Developing; $N = 34$ participants. RD = Reading Difficulties; $N = 28$ participants. PA = Phonological Awareness, PM = Phonological Memory, RAN-D = Rapid Digit Naming, RAN-L = Rapid Letter Naming.

Reading Efficiency Test (TOWRE)

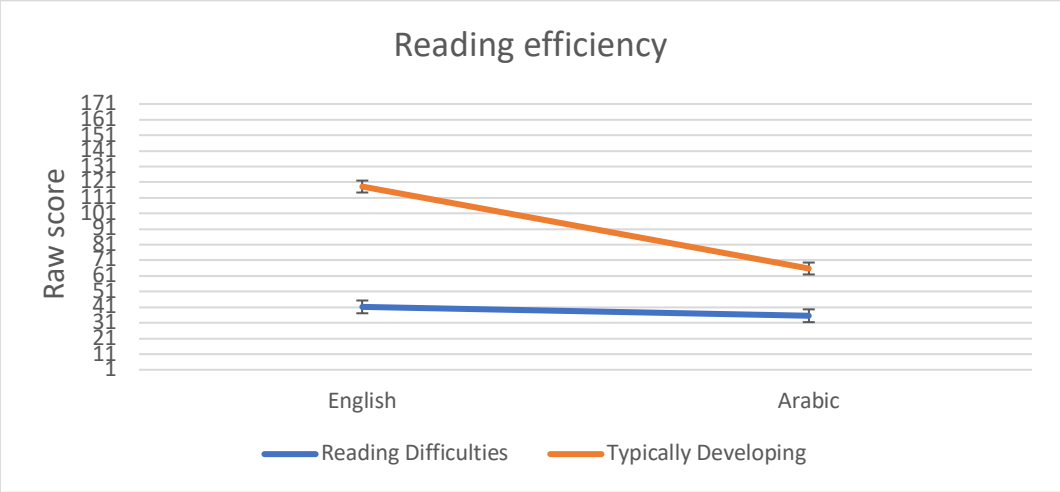
The results of the language (English, Arabic) x group (TD, RD) mixed ANOVA revealed that there was a significant effect of language: reading efficiency in English was better than reading efficiency in Arabic, $F(1, 60) = 110.17$, $p < .001$, $\eta^2p = .65$. There was a significant main effect of group: the TD children performed better than the RD children, $F(1, 60) = 141.39$, $p < .001$, $\eta^2p = .70$. Additionally, there was a significant interaction between language and group, $F(1, 60) = 71.30$, $p < .001$, $\eta^2p = .54$ (see Figure 6.1).

This interaction was then explored through a post-hoc test with Bonferroni correction. The Bonferroni correction needed to be $p < .008$ to be significant, which indicated that there was a difference between the RD and TD children in English (*Mean Difference* = 79.69, 95% CI [74.45, 84.93], $p < .001$), with the TD children's scores being higher than the RD children's. In addition, there was a significant difference between the groups in Arabic (*Mean Difference* = 50.65, 95% CI [45.31, 55.98], $p < .001$), although means suggest that the between-group difference was larger in English than in Arabic.

To further account for the significant interaction, there was no significant difference between languages for the RD children (5.68, 95% CI [-2.52, 13.87], $p = .17$). However, there was a significant difference between reading in English and Arabic for the TD children (52.41, 95% CI [44.97, 95.85], $p < .001$), with their reading efficiency in English (M = 118.47) being better than their reading in Arabic ($M = 65.67$; see Figure 6.1).

Figure 5.1

Means and Standard Errors of Reading Efficiency of TD and RD Children in English and Arabic



Note. Error bars show standard errors.

Reading Accuracy Test (DTWRP)

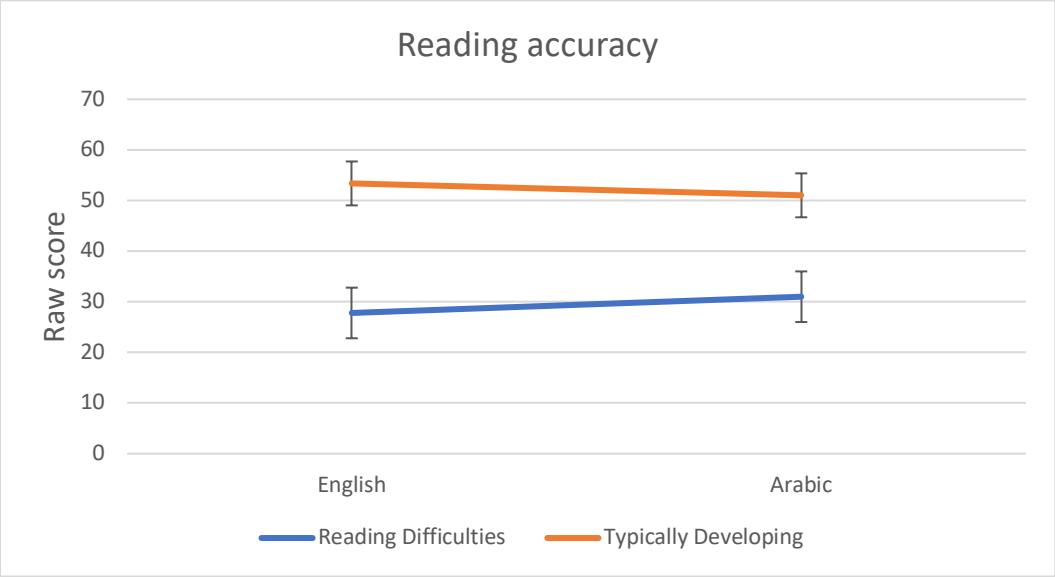
The results of the language (English, Arabic) x group (TD, RD) mixed ANOVA revealed that there was no significant effect of language, $F(1, 60) = .250$, $p = .62$, η2p = .004. There was a significant effect of group, $F(1, 60) = 80.82$, $p < .001$, $\eta^2p = .57$, and a significant interaction between language and group, $F(1, 60) = 8.57$, $p < .005$, $\eta^2p = .12$ (see Figure 6.2).

This interaction was then explored through a post-hoc test with Bonferroni correction, which indicated that there was a difference between the RD and TD children in English (*Mean Difference* = 25.59, 95% CI [20.45, 30.74], $p < .001$), the TD children's scores being higher than the RD children's. There was also a significant difference between the groups in Arabic (*Mean Difference* = 19.92, 95% CI [14.24, 25.61], $p < .001$), with the TD children reading more accurately than the RD children in Arabic.

With regard to the simple effect of language, there was no significant difference between languages for the RD children (3.32, 95% CI [.45, 6.19], $p = .02$). There was also no significant difference in reading accuracy between English and Arabic for the TD children, which was not the case for reading efficiency (2.35, 95% CI [-4.96, .25], $p = .08$; see Figure 6.2).

Figure 5.2

Means and Standard Errors of Reading Accuracy of TD and RD Children in English and Arabic



Note. Error bars show standard errors.

Phonological Awareness Test (PA)

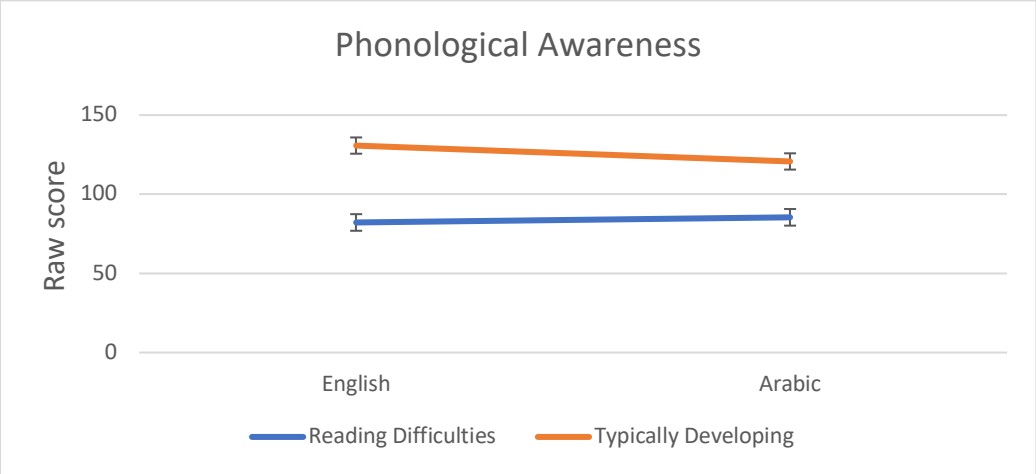
As shown in Figure 6.3, in the phonological awareness tasks, there was no significant effect of language, $F(1, 60) = 6.41$, $p = .01$, η2p = .09. There was a significant main effect of group; the TD children performed better than the RD children, $F(1, 60) = 73.34$, $p < .001$, $\eta^2 p = .55$. Moreover, there was a significant interaction between language and group, $F(1, 60) = 24.60$, $p < .001$, $\eta^2 p = .29$.

This interaction was then explored through a post-hoc test with Bonferroni correction, which indicated that there was a difference between the RD and TD children in English (*Mean Difference* = 48.59, 95% CI [38.35, 58.83], $p < .001$), the TD children's scores being higher than the RD children's. There was also a significant difference between the groups in Arabic (*Mean Difference* = 35.31, 95% CI [25.23, 45.38], $p < .001$), although again, the difference seemed slightly smaller on the Arabic than the English tests.

To further account for the significant interaction, there was no significant difference between languages for the RD children (95% CI [-7.22, .72], $p = .11$). However, there was a significant difference between PA in English and Arabic for the TD children (95% CI [-6.43, 13.63], $p < .001$), with their PA in English ($M = 130.76$) being better than their PA in Arabic ($M = 120.73$; see Figure 6.3).

Figure 5.3

Means and Standard Errors of Phonological Awareness of TD and RD Children in English and Arabic



Note. Error bars show standard errors.

Phonological Memory Test (PM)

In the phonological memory tasks, there was no significant effect of the language, $F(1, 60) = 3.21$, $p = .08$, $\eta^2p = .05$, as the adjusted Bonferroni should be $p < .008$. There was a significant main effect of group; the TD group performed significantly better than the RD children, $F(1, 60) = 114.55$, $p < .001$, $\eta^2p = .66$. The interaction effect between language and group was non-significant, $F(1, 60) = 1.41$, $p = .24$, $\eta^2p = .02$.

Rapid Automatised Naming (Rapid Letter Naming)

Figure 6.4 shows that there was a significant effect of the language, $F(1, 60) = 9.96$, $p < .002$, $\eta^2p = .14$. Moreover, there was a significant main effect of group, $F(1, 60) = 33.02$, $p < .001$, $\eta^2p = .35$. There was a significant interaction between language and group, $F(1, 60) = 11.26$, $p < .001$, $\eta^2p = .16$ (see Figure 6.4).

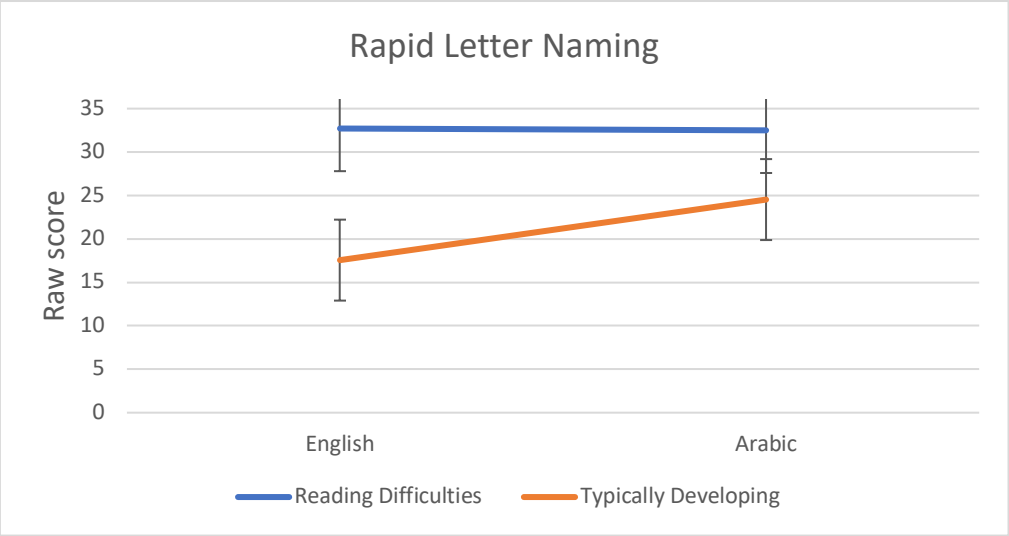
As the interaction reached a significant level, a pairwise comparison was conducted, which showed that the groups significantly differed in the English test, with the TD children scoring higher than the RD children (*Mean Difference* = 15.15, 95% CI [10.88, 19.43], $p < .001$); they also significantly differed in Arabic (*Mean Difference* = 7.97, 95% CI [3.14, 12.79], $p < .002$). As shown in Figure 6.4, the difference was larger in English than in Arabic.

There was no significant difference in the performance of the RD children between RAN letters in English and RAN letters in Arabic (*Mean Difference* = .21, 95% CI [-2.96, 3.38], $p = .89$). However, there was a significant difference in the performance of the TD children

between RAN letters in English and RAN letters in Arabic (*Mean Difference* = 6.97, 95% CI [4.09, 9.85], $p < .001$); the TD children performed better in naming letters in English (M = 17.56) than in Arabic (M = 24.53; a lower number indicates faster reading).

Figure 5.4

Means and Standard Errors for Rapid Automatised Naming of Letters in English and Arabic of TD and RD Children in English and Arabic



Note. Error bars show standard errors.

Rapid Automatised Naming (Rapid Digit Naming)

For rapid digit naming (see Figure 6.5), there was a significant effect of language, $F(1, 60) = 8.10$, $p < .006$, $\eta^2p = .12$. However, there was no significant effect of group, $F(1, 60) = 7.16$, $p < .01$, $\eta^2p = .11$. There was a significant interaction between language and group, $F(1, 60) = 27.16$, $p < .001$, $\eta^2p = .31$.

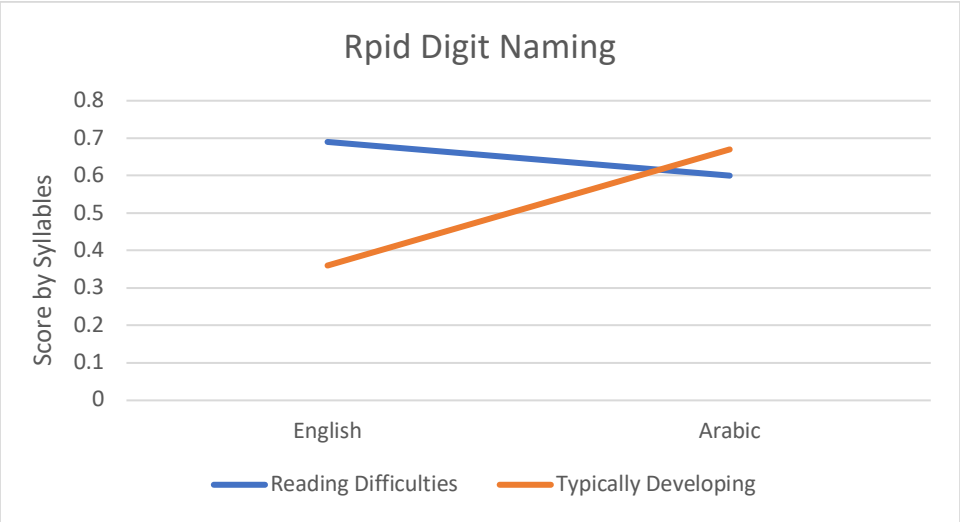
As the interaction reached a significant level, a pairwise comparison was conducted, which showed that the groups differed significantly in the English test, with the TD children scoring higher than the RD children (*Mean Difference* = .33, 95% CI [.21, .45], $p < .001$); however, they did not differ significantly in Arabic (*Mean Difference* = .06, 95% CI [-.06, .19], $p = .32$).

There was no significant difference in the performance of the RD children between RAN digits in English and RAN digits in Arabic (*Mean Difference* = .09, 95% CI [-.02, .20], $p = .12$). However, there was a significant difference in the performance of the TD children between RAN digits in English and RAN digits in Arabic (*Mean Difference* = .30, 95% CI [.20, .40], $p < .001$); the TD children performed better in reading digits in English (M = .36)

than in Arabic (M = .67; a lower number indicates faster reading). More detail about the method used with RAN digits is presented in Section 3.6.4.

Figure 5.5

Means and Standard Errors for Rapid Automatised Naming of Digits in English and Arabic of TD and RD Children in English and Arabic



Note. Error bars show standard errors. A higher score means slower performance.

In summary, there was a significant difference in reading efficiency between the typically developing bilingual children and those with reading difficulties, and the TD children read more efficiently than the RDs in both English and Arabic. For reading accuracy, there was a significant effect of group on reading accuracy, and TD children read more accurately than the RDs in both languages. There was no significant effect of language on reading accuracy.

Further, the TD bilingual children performed better than the RD children in PA skills, and they performed better in reading English than Arabic. There was no significant difference between performance on Arabic PA and English PA for the RD children. Regarding rapid letter naming, the TD children named letters faster in English and Arabic than the RD children. There was no significant difference in the performance of the RD children between RAN letters in English and RAN letters in Arabic. However, there was a significant difference in the performance of the TD children between RAN letters in English and RAN letters in Arabic, with the children naming letters faster in English.

The TD children scored higher than the RD children only on the English rapid digit naming. There was a significant difference in the performance of the TD children between RAN digits in English and RAN digits in Arabic, and they named digits faster in English.

However, there was no significant difference in the RD children's performance between RAN digits in English and RAN digits in Arabic.

There was no significant effect of language on PM, but there was a significant effect of groups on PM, with the TD children performing better in PM than the RD children.

This general analysis followed the same pattern as in the subgroup analyses. In both the subgroup analysis and the overall study, the TD children performed better in English than the RD children. In Arabic rapid digit naming, there was no difference between the TD and RD groups in the overall analysis, and in the subgroup, there was also no difference between the RD and TD groups in Arabic rapid digit naming and Arabic letter naming. It appears that the discrepancies across groups are not attributable to differences in schools, as the result for the subgroup is similar to the overall group in terms of low performance in reading measures and phonological processing skills. However, the small size of the subgroup should be taken into consideration.

5.6.4 Findings From the Home Languages Questionnaire for the RD Group

An independent samples *t*-test was conducted to compare the home language usage of the RD and TD children to determine whether there was a systematic difference between them. The Bonferroni method was used, so the *p*-values to determine significance were adjusted to 0.05/7 = 0.007. The children were asked to indicate their responses on a five-point Likert scale, for which 0 indicated Never and 4 indicated All of the time, which languages (Arabic and English) they spoke with their parents (mother and father separately), siblings and friends (see Appendix 3).

Table.5.6

Mean Scores of Children's Responses (RD With TD) Concerning Speaking in English With Their Parents, Siblings, School Friends, Having Dinner, Watching TV and Reading for Pleasure Time

Exposure to English	RD Mean (*SD*)	TD Mean (*SD*)	*p*-value
Speaking to parents	1.95 (.69)	.72 (1.07)	.001
Speaking to siblings	2.50 (1.43)	2.44 (1.73)	.89
Speaking to school friends	1.43 (.84)	3.59 (.56)	.01

Exposure to English	RD Mean (*SD*)	TD Mean (*SD*)	*p*-value
Speaking to friends outside school	2.86 (.76)	3.38 (.85)	.001
Having dinner	2.39 (.99)	2.26 (.93)	.60

Note. TD children, $n = 34$ participants; RD children, $n = 28$ participants. Due to the Bonferroni correction, the *p*-value should be $p < .007$ to be significant.

As shown in Table 6.7, there was a significant difference between the groups on some measures of language exposure and usage; the children with reading difficulties spoke more English with their parents than the TD children, $t(60) = 5.19$, $p < .001$. Also, the TD children spent more time speaking to their friends outside school in English than the RD children, $t(60) = -12.15$, $p < .001$. However, there was no significant difference between the groups in speaking English to their siblings or friends at school. There were no significant differences between the groups in their use of English when having dinner with their family.

In summary, the findings revealed that English was widely used with family, particularly with parents of children with reading difficulties. There was no difference between the children with reading difficulties and TD children in the use of English with their siblings. The children with reading difficulties spoke less English with their friends outside of school than the TD children. Both groups had similar English use for having dinner.

5.7 Discussion

5.7.1 Identifying Children With Reading Difficulties in This Study

The bilingual RD children in this study were identified as children with reading difficulties based on their low literacy achievement and academic discrepancies, for example, if they received low scores on informal word reading tests. In addition, the SEN teacher tested their IQ scores to make sure their IQ was in the average range. This entire approach follows the discrepancy model.

5.7.2 Comparing TD Children and RD Children

One strength of the design of Study 2 is that the analysis for the subgroup of children within the same school indicated that the TD group outperformed the RD group in reading and phonological processing skills. Both groups followed the same education system in the

same international school in the KSA (School C) and had the same balance of exposure to English and Arabic. However, there were still significant differences between the groups. The limited size of this sample must be taken into account when interpreting the results. The bilingual children with reading difficulties received the same teaching instruction in learning Arabic, in addition to the support they received in the resource room from the SEN teacher; however, they performed poorly in reading skills and phonological processing skills. This indicates that the teaching instruction they received should be revised and should include PA and RAN interventions that might lead to improved reading ability (Ball & Blachman, 1991; Vander Stappen & Reybroeck, 2018; Vander Stappen et al., 2020).

The findings for phonological processing are consistent with the phonological deficit hypothesis. According to this hypothesis, the main reason an individual with RD has difficulty acquiring literacy is a lack of phonological awareness. PA is part of the phonological processing deficit found in dyslexia (Ramus et al., 2003; Ziegler & Goswami, 2005). The children with reading difficulties showed a deficit in PA in both Arabic and English compared to the biliterate TD children. The RD children in this study also had a deficiency in PM, as well as demonstrating poorer performance on RAN in English than the TD children. This finding is consistent with the claim that RAN is an important measure for early identification of the risk for reading impairments (Georgiou et al., 2012). The results could not be extended to Arabic since there were no statistically significant differences in Arabic RAN digit performance between the RD and TD biliterate children, and both groups were similarly slow at completing the RAN tasks.

5.7.2.1 Reading Efficiency and Accuracy in English.

The results showed that there was a significant difference in reading efficiency between the selected biliterate typically developing children and bilingual children with reading difficulties in that the TD children read more efficiently than the bilingual children with reading difficulties in both English and Arabic, and there was a significant interaction between language (English and Arabic) and group (RD and TD). For reading accuracy, there was no significant effect of language, but there was a significant effect of group in reading accuracy: the TD children outperformed the RD children in the reading accuracy test in both languages. They could read Arabic as accurately as English, perhaps because of the consistent nature of Arabic orthography, although they were still slow in Arabic.

The children in this study whose L1 was Arabic, a language with a transparent orthographic system, were reading English, a non-transparent language, as their L2. This can

be a challenge for children with reading difficulties, as their key difficulty may be establishing grapheme–phoneme correspondences (Ziegler et al., 2003; Ziegler et al., 2007). As expected, the TD children outperformed the RD children in reading efficiency and reading accuracy tests in English. This supports evidence that children with reading difficulties show deficits in reading skills in an opaque language (English; Jong & Leij, 2003; Lander, 1997). It is likely that children with reading difficulties find reading in both transparent and non-transparent languages challenging.

A possible explanation for why children with reading difficulties perform poorly in reading efficiency and accuracy is that their decoding performance is more sensitive to word length, where the word length effect is the link between naming time and the number of letters (Verhoeven & Keuning, 2018). It can thus be suggested that the RD group had phonological processing difficulties, which impacted their ability to alphabetically decode words. If their reading depended on alphabetic decoding, then they would be subject to word length effects, so problems in reading would be more pronounced for longer words. The length of the words impacts the efficiency of reading both words and nonwords (De Luca et al., 2002; Zoccolotti et al., 2005).

Juphard et al. (2004) stated that the length of a word affects the efficiency of reading for beginner readers, particularly high-frequency words, while the effect is smaller for experienced readers. Presumably, more experienced readers have more words stored in their orthographic lexicon, so they can read by accessing this stored knowledge rather than via alphabetic decoding. Reading lexically is less likely to show the effects of word length (Castles, 2006). Children with reading difficulties have greater difficulty decoding than TD children. The reading efficiency test in English contains a list of words that starts with high-frequency words and progresses to low-frequency ones, so the children might find these words, especially the low-frequency words, hard to read efficiently. Most of the reading words and nonwords start with two letters and increase in length.

5.7.2.2 Reading Efficiency and Accuracy in Arabic.

The results showed that the selected biliterate TD children outperformed the children with reading difficulties, who performed poorly in reading efficiency and reading accuracy in Arabic. A possible explanation for this might be that although Arabic is a transparent language when presented with diacritic marks (vowelising words), children with reading difficulties may find that using short vowels does not improve their reading efficiency and accuracy. This finding does not support the findings of Abu-Rabia (1997, 2001, 2007, 2012),

Abu-Hamour et al. (2013) or Midhwah and Alhawary (2020). However, the children with reading difficulties in this study may have read less efficiently and accurately than the selected biliterate TD children because short vowels make Arabic reading more complex and challenging for them. This is in line with Ibrahim (2013) and Asadi et al. (2017), whose findings suggested that the use of short vowel diacritics had no effect on reading efficiency. Moreover, vowelisation does not assist reading accuracy in Arabic, since it appears that readers with RD cannot rely on it as a tool to facilitate accuracy due to difficulties in grapheme–phoneme decoding.

Another possible explanation for this is that the orthographic features of the Arabic language may affect reading efficiency and accuracy. As previously discussed, orthographic depth affects reading in English, and the orthographic structure of Arabic affects reading skills in Arabic. It is difficult to conclude that reading in English is easier than reading in Arabic, as both languages have different orthographies. In Arabic, there are things unique to the Arabic orthography that should be closely analysed, such as connected letters in words, each letter having a different shape depending on the position of the letter and some letters written with dots over or under the letter. This increases the visual load and potentially decreases reading speed. The low reading efficiency and accuracy in Arabic for both groups reported in this study are in line with Eviatar and Ibrahim (2000), Layes et al. (2021), Taha et al. (2012) and Friedmann and Haddad-Hanna (2012), who found that the orthographic form of the Arabic language affects the process of reading the words. Moreover, all the factors considered in Study 1 that could prevent the TD children from developing their reading in Arabic, such as the visual complexity of Arabic orthography, exposure to the language and diglossia, can also apply to children with reading difficulties.

These results, the low performance in reading accuracy and efficiency, might support the idea that the Arabic script does not function like other transparent alphabets (Seymour et al., 2003; Ziegler & Goswami, 2005). This leads to the suggestion that in addition to consistent grapheme–phoneme correspondences, the orthographic depth of a language should include aspects of the orthographic system, such as the high degree of complexity in Arabic orthography, which affects the reading performance of children with reading difficulties.

5.7.2.3 Phonological Processing Skills.

On the phonological awareness tasks, the selected biliterate TD children performed better overall. Similarly, for phonological memory, the selected biliterate TD group performed better than the children with reading difficulties. Finally, in the RAN (digits and letters) task,

the TD children outperformed the children with reading difficulties in English but not in Arabic RAN digits, with both groups performing poorly in reading Arabic numbers.

The current study did not test the double deficit theory due to the small sample of children but did examine whether children with PA and RAN deficits had poorer reading skills. According to Wolf and Bowers (1999), those with combined RAN and PA deficiencies face more significant difficulties than those with single deficits in all reading skills. The results showed that students with reading difficulty had lower scores in Arabic and English reading skills (efficiency and accuracy), PA, PM and RAN (letters and digits) compared with the selected TD children in Arabic and English. Therefore, RAN and PA deficits are associated with reading problems. Children at risk for dyslexia have been found to have deficits in PA and RAN relative to their peers (Araújo & Faísca, 2019; Asadi & Shany, 2018; Capellini et al., 2008; Cronin, 2011; Deuschle & Cechella, 2009; Germano et al., 2008; Hornung et al., 2017; Justi & Cunha, 2016; Kirby et al., 2003; Kirby et al., 2010; Lima et al., 2008; Michalick-Triginelli & Cardoso-Martins, 2015; Norton et al., 2014; Peterson et al., 2017; Peterson & Pennington, 2012; Torppa et al., 2013; Wimmer et al., 2000; Wolf & Bowers, 1999).

Another limitation of the children with reading difficulties was that they performed poorly on the PM test in Arabic and English compared to the TD children, which indicates the essential role of phonological memory in distinguishing children with and without reading difficulties in both English and Arabic. This difference might be because the TD children did not have deficits in their PM, which gave them an advantage in their reading skills. Children with reading difficulties have deficits in short-term memory, which impacts their reading skills.

Evidence of the relevance of phonological memory as an indicator of reading difficulties is provided in this study, which shows the low performance of RD children in PM. Children with reading difficulties underperform on memory span tasks because linguistic memory relies on the stimulation of phonological codes (Kibby & Cohen, 2008). In children with reading difficulties, studies conducted in different languages have demonstrated limitations in verbal memory abilities (Griffiths & Snowling, 2002; Seigneuric et al., 2000). Poor PM is observed in children with reading difficulties (Jeffries & Everatt, 2004) and is associated with poor educational outcomes (Gathercole & Pickering, 2000).

The children with reading difficulties group scored lower than the TD group in English RAN digits but not in Arabic. This potential difference of output in Arabic and English on the RAN digit tasks may be because Arabic digits have more syllables than English digits and thus require a greater memory load, despite the researcher controlling for this by taking into account the number of syllables (see methodology chapter, Section 3.7.3.1). Furthermore, all the children in the current study used English digits in math, with less exposure to Arabic digits. As the TD children performed low in RAN digits and letters in Study 1, further discussion can be found in Section 4.4.

Children must understand how particular letters are related to specific phonemes. Asaad and Eviatar (2013) reported that the retrieval of the names or sounds of Arabic letters with visual and phonological neighbours was slower than the retrieval of letters with only visual neighbours. As in Arabic letters, some phonological attributes allow some letters to be phonologically similar. It is possible that the RD children in the current study spent more time distinguishing between these letters in their minds.

The bilingual children with reading difficulties spoke more English with their parents than the TD children, while the TD children spent more time speaking English with their friends in school than the RD children. The Home Languages Questionnaire revealed the relative amounts of Arabic and English used inside and outside the home. The RD and TD children appeared to differ in their exposure to English and its use in activities performed at home. The children with reading difficulties interacted with their parents more frequently in English than the TD children. It is likely that the parents spoke more English with their children than Arabic, as they wanted to encourage them to learn English. If parents opt to enrol their children in international schools, this usually indicates that they are supportive of their English learning, and as a result, they may be more likely to speak in English with them. Regardless, the children with reading difficulties performed poorly in English reading skills compared to the TD children.

Although the bilingual children with reading difficulties were exposed to more English than Arabic, their difficulties were similar in both languages: they read less accurately and less efficiently and demonstrated lower performance in phonological processing skills in both languages than the TD biliterate children. These findings are consistent with the definition and probable explanations for children with reading difficulties that have been established in the literature. The basic indicators of phonological processing difficulties in children with reading difficulties are broadly agreed upon: they include poor PA, poor PM and slow RAN.

The main explanation underlying cognitive difficulties in children with reading difficulties is phonological processing difficulty (Rose, 2009; Vellutino et al., 2004). Learning difficulty mostly affects the ability to read and spell accurately and fluently (Rose, 2009). Identifying phonemes is a problem for children who have reading difficulties, as well as blending sounds into words because they cannot correlate the sound with the letter symbol. The development of reliable and effective phonemic decoding skills is more challenging for children with reading difficulties than for typical readers (Schatschneider & Torgesen, 2004).

To summarise, the current study aimed to assess whether phonological processing skills and reading skills differ between typically developing biliterate children and bilingual children with reading difficulties in Arabic and English, and if so, which aspects of phonological processing are most impaired in children with reading difficulties. This was done by administering tasks of reading efficiency, reading accuracy and phonological processing skills in English and Arabic. The bilingual children with reading difficulties appeared to have normal IQ test scores based on the WISC in Arabic and the WASI in English. The bilingual children with reading difficulties performed poorly in reading and phonological processing skills in both languages compared to the biliterate TD children. The bilingual children with reading difficulties read less efficiently and accurately in Arabic due to its orthographic system when presented with short vowels (diacritics marks), which did not seem to help the children with reading difficulties in reading Arabic. The high degree of Arabic visual complexity and diglossia may affect children with reading difficulties.

The results from the phonological processing tests demonstrated that the bilingual children with reading difficulties performed more poorly than the selected biliterate TD children in all the phonological processing subtests in both languages, except for RAN digits in Arabic, in which both groups showed similar performance. However, as the biliterate children and children with reading difficulties had received little exposure to Arabic digits, it is difficult to draw any conclusions about RAN digits in Arabic. In conclusion, appropriate methods for identifying bilingual children with reading difficulties that address different reading skills in different orthographies need to be developed. Based on the current findings, regardless of how they were identified, the children who were indicated as having learning difficulties appeared to have reading difficulties.

The next chapter presents the general discussion and concludes the studies.

Chapter 6 General Discussion

6.1 Introduction

Bilingualism is defined as the ability of a speaker to communicate in two languages. Bilingualism is a complex matter, so research on the subject draws on the literature from a range of fields, including linguistics, psychology, neurology and education. Bilingualism research focuses on bilingual speakers' language habits, their social and pragmatic patterns of using two languages, and their language production, acquisition and loss, among other topics. Scholars are attempting to understand the modes of bilingualism and the impact of bilingualism on human cognition, societal relationships and bilingual children's education, while multiple aspects of bilingualism and academic learning have been examined (Bialystok & Herman, 1999; Gathercole, 2014; Green & Abutalebi, 2014; Lauchlan et al., 2012).

The aim of this study was to add to the growing body of knowledge about bilingual children's reading skills and phonological processing abilities. The overall purpose was to explore the relationships between multiple aspects of phonological processing and reading abilities, beginning with an examination of typically developing bilingual Arabic–English speaking children and progressing to an investigation of bilingual primary school children with reading difficulties. An additional objective for this research was to examine phonological processing in more depth to determine whether phonological awareness, phonological memory and/or RAN skills are particularly essential.

Phonological processing abilities are critical to the development of accurate and fluent reading skills in English (Perfetti, 1985; Torgesen & Burgess, 1998; Wagner et al., 1993) and other languages (Caravalos & Bruck, 1993; Comeau et al., 1999; Durgunoglu & Oney, 1999; Geva, 2000). As phonological processing is a predictor of reading outcomes in most languages, researchers consider it a universal predictor (Anthony & Francis, 2005; Ziegler & Goswami, 2005). While we know much about the role of phonological skills in the reading ability of monolingual children, especially those who speak English, we know much less about the phonological skills of bilingual learners, including those of bilingual children who speak languages with very different orthographies, such as English and Arabic. Thus, research must move its focus from alphabetic European languages, particularly English (D. L. Share, 2008), to other, more varied (but widely spoken) Asian and African languages because the role of phonology varies across different types of orthographies.

This chapter begins with a summary of the results from Studies 1 and 2 and goes on to discuss the findings, considering what we know about the role of the phonological processing

skills in typically developing children and what we know about the diagnosis of bilingual children with reading difficulties. Next, possible reasons to explain why the biliterate children performed better in the English language than in Arabic are outlined, as is the importance of reading assessments for bilingual children. Finally, theoretical and practical implications and the limitations of the study are described, and suggestions for future research in this area are presented.

6.2 Summary of Results of the Present Research

6.2.1 Study 1

The current research was accomplished through two studies. The first study involved a comparison of typically developing biliterate Arabic–English children's reading and reading-related skills in English and in Arabic, as well as a comparison of reading and reading-related skill performance across two countries: the UK and KSA. As part of Study 1, each child's home language environment was analysed to determine if the child used either of the languages (English or Arabic) more frequently. The results of the first study, which showed that some of the children performed much more poorly in Arabic than in English, indicated some of the children were not equally biliterate in both languages. Based on this evidence, the researcher decided to select a biliterate group for subsequent analyses. To form this group, children who performed below 1.5 standard deviations from the mean in either language were excluded, as this result suggested they were not fully literate in both languages. An analysis was then conducted to compare the biliterate children's reading and reading-related skills in English with their skills in Arabic and to compare the performance of all children classified as biliterate in reading and reading-related skills across two countries: the UK and KSA. The results are likely to apply to children who are biliterate in Arabic and English, given a substantial proportion of the sample was close to the performance ceiling in both English and Arabic reading accuracy and PM skills. However, the biliterate children performed poorly on the Arabic RAN digits task, suggesting that some were not familiar with reading Arabic numbers.

Language had a significant effect on the reading efficiency of the biliterate children, who performed better in English than in Arabic. However, country did not have a significant effect on the reading efficiency of this group, and no significant interaction was found between language and country. Furthermore, neither language nor country had a significant effect on reading accuracy.

The results of Study 1 further indicated that language had a significant effect on PA, as the biliterate children performed better on PA test in English than in Arabic. However, country had no significant effect, and no significant interaction between language and country was observed for this group. Meanwhile, neither language nor country had a significant effect on PM, and no significant interaction was found between language and country in that context. There was, however, a significant effect of language on RAN letters task performance, with the children performing better in English than in Arabic, while country had no significant effect on RAN letters task performance, and no significant interaction between language and country was observed.

Finally, both language and country were shown to have a significant impact on RAN digits task performance, with the biliterate children in the UK performing better in English than those in the KSA, and a significant interaction was evidenced between language and country. Furthermore, the RAN digits assessment performance of children in the UK in Arabic was significantly different than the performance of children in the KSA in Arabic: more specifically, children in the UK read Arabic digits and English digits faster than children in the KSA read them. However, children in the KSA showed no significant differences between reading digits in English and in Arabic.

The findings from Home Languages Questionnaire revealed that the children used English and Arabic equally with their parents and siblings. Moreover, children in the UK used English more often than children in the KSA used the language. Indeed, children in the KSA spoke English less frequently with their friends in and outside of school and when having dinner compared to children in the UK.

In view of the findings from first and second research questions, comparison was performed with Arabic monolingual children to determine whether the relatively poor performance in Arabic compared to English of the biliterate participants was due to lack of exposure to Arabic or to the quality of Arabic language reading instruction. An answer to this inquiry was sought by comparing the reading skills and phonological processing skills of monolingual Arabic speakers with those of the biliterate children in Arabic. In addition, PA, PM and RAN (letters and digits) were measured to examine whether a pattern of predictive relationships in monolingual Arabic children emerged.

A series of ANCOVAs revealed significant differences between the levels of Arabic reading efficiency of the biliterate children and monolingual readers. There was no

differences in reading accuracy performance were found between the biliterates and monolinguals. In addition, the monolinguals slightly outperformed the biliterates in the PA and PM tasks, and they completed the RAN (digits and letters) tasks much more quickly.

Furthermore, regression analyses revealed that the monolingual Arabic speakers' PA assessment performance and RAN digits assessment performance were significant predictors of their word reading efficiency in Arabic. Only PA was a significant predictor of Arabic word reading accuracy.

6.2.2 Study 2

Study 2 included bilingual Arabic–English children with reading difficulties (RD) who were chosen by their teachers based on their poor attainment in literacy. The patterns of reading accuracy, reading efficiency and phonological processing performance for this group of children were compared to those of the typically developing (TD) biliterate children from Study 1. The comparison of data from the TD children and the RD children subgroups within the same school showed that the TD group outperformed the RD group in all reading and phonological processing skill measures.

The results for the comparison of RD and selected TD students across the schools pointed to a significant difference in reading efficiency levels between the biliterate TD children and the RD bilingual children, as the TD children read more efficiently than the RD children in both languages, English and Arabic. In addition, a significant interaction between language (English and Arabic) and group (RD and TD) was observed, with the TD children scoring relatively higher in English than in Arabic. Moreover, language had no significant effect, but group did significantly affect reading accuracy performance: specifically, the TD children read more accurately than the RD children in both languages. The children's performance on the English and Arabic versions of the phonological awareness tasks did not differ significantly; however, the TD children performed better overall. Similarly for PM, the TD group performed better than the RD group. Finally, regarding the RAN letters and digits tasks, the TD children outperformed the RD children on the English language and Arabic RAN letter assessments, while both groups performed poorly on the Arabic RAN digits tasks. A significant interaction was found between language and group, indicating that the TD children scored higher than the RD children in English, but the groups did not significantly differ on the Arabic RAN digits tasks.

The Home Languages Questionnaire findings revealed that English was widely used inside the family, particularly with parents of children with RD, while no difference was found in the use of English language between the RD and TD children and their siblings. The children with RD spoke English less often with their friends outside school compared to the TD children, and both groups reported similar activities at home, such as having dinner. The questionnaire results also revealed that the TD group had more exposure to the English language than the RD group.

6.3 The Role of Phonological Processing in Typically Developing Children

6.3.1 Phonological Awareness

The key role played by PA highlighted in the findings lends further evidence to PA's well-established function in reading across different orthographies, which has been demonstrated in previous research (Caravolas et al., 2005; Geva & Wang, 2001). According to regression analyses completed for Studies 1 of the current research, PA strongly predicted reading accuracy and reading efficiency performance in monolingual children in Arabic. PA also plays a significant role in reading development within orthographies (Wagner & Torgese, 1987; Wagner et al., 1994); furthermore, it is assumed to be a universal predictor of reading across alphabetic languages (Caravolas et al., 2012, 2013; Landerl et al., 2019), and although the Arabic language is an abjad language, PA predictor of reading skills in Arabic (Hassanein et al., 2022; Mannai & Everatt, 2005; Tibi & Kirby, 2018; Tibi et al., 2019). (In an abjad language, consonants are largely represented, while vowels are only optionally included; see page 36 for more information.)

The monolingual children who participated in Study 1 attended private schools where the primary language spoken was Arabic. A regression analysis showed that of PA, PM and RAN skills, PA had the strongest impact on the accuracy and efficiency of a child's word reading. This finding is generally consistent with the findings of prior studies in Arabic. While the current study demonstrated that PA predicts Arabic word reading accuracy, as many others (Asaad & Eviatar, 2014; Layers et al., 2015; Taibah & Haynes, 2011; Tibi & Kirby, 2018) have done in the past, the results of this study expanded this finding to incorporate Arabic word reading efficiency also.

The finding on the important role of PA as a predictor of reading efficiency and accuracy in Arabic monolingual children concurs with the results from many research studies in this area, such as those conducted by Mannai and Everatt (2005), Al-Sulaihim and Marinis (2017), Asadi et al. (2017), Elbeheri and Everatt (2007), Layes et al. (2015), Taibah and

Haynes (2010), Tibi and Kirby (2018) and, recently, Hassanein et al. (2022). Most of these studies showed that PA is a key predictor of reading skills in Arabic learners. Moreover, these findings are in line with previous research on the consistent orthographies of the Czech and Greek (Caravolas et al., 2005) and Hebrew (Geva & Wang, 2001) languages and with previous research on an inconsistent orthography (English). In addition, PA as a predictor of reading efficiency has also been found in bilingual English–Arabic children (Geva & Saiegh-Haddad, 2008).

6.3.2 Phonological Memory

There was no significant difference on the PM tasks was observed in the children's performance in the two languages for the biliterate children. This result suggests that PM depends on phonological representations (Abu-Rabia & Siegel, 2002; Harrison et al., 2016). Phonological memory is needed to retain sounds during learning decoding and then to store sound segments created during word decoding (Wagner & Torgesen, 1987). For example, in the nonword repetition task, participants must remember an unfamiliar sequence of sounds without using the lexicon. The test utilises PA abilities because the participant must correctly assess and code the pseudo-sounding word's structure for its storage in memory, which supports the subsequent articulation process (Snowling et al., 1991).

However, the monolingual children outperformed the biliterate children on PM tasks. Previous work on L2 PM (Messer et al., 2010; Windsor et al., 2010) has shown that monolinguals outperformed bilinguals on some PM tasks, and monolinguals clearly had an advantage over the selected biliterate children in PM in the current research. The reason for this may be that the biliterate children may not have had adequate skills in Arabic to allow them to form the accurate phonetic knowledge to influence verbal short-term recall. Indeed, PM is a specialised form of memory that is thought to be responsible for the short-term storage of sounds and the coding of phonological information, which are involved in cognitive processes (Melloni & Vender, 2020).

Children with reading difficulties performed poorly on the PM tasks, according to the current findings. A link exists between PM and PA: during the process of decoding a word, the sequence of phonemes that is produced as a result of the grapheme-to-phoneme conversion needs to be held in some form of short-term buffer so that it can be assembled and then matched to phonological lexical representations that are stored in long-term memory, with each step depending on PM (Gathercole, 1995; Gathercole et al., 2006). Difficulties with

PM are commonly recognised as potentially leading to difficulties performing PA tasks, such as blending and segmenting phonemes (Dollaghan & Campbell, 1998; Gathercole et al., 1994).

Another possible explanation for the poor performance of RD children on PM tasks is that PM skills are required for alphabetic decoding. Phonological recoding begins with the recognition of target graphemes, followed by the mapping of those graphemes into smaller phonological units, such as phonemes or syllables, and finally, the blending of those units into the final pronunciation of the entire string. Later, the phase of recognising graphemes and blending their corresponding phonological units occurs more quickly and internally, virtually in conjunction with the utterance of the complete string. The ability to recall the association between a string of graphemes and a phonological form is likely dependent on the ability to pronounce the string as a whole without a significant pause between processing its individual components. With respect to reading ability, PM has clear direct implications because PM is required to learn and remember new words in addition to remembering sounds within a word whilst sounding it out (Gathercole et al., 2006; Wagner & Torgesen, 1987). Children who have problems with PM, therefore, have difficulties in reading fluency because they forget sounds and syllables and then misread words because it is difficult for them to recall what they read (Aksoy-Tercan et al., 2012). For the word 'seashell', for instance, an individual must first sound out the first few phonemes, put those together and hold them in memory while sounding out the few phonemes that follow. After that, the individual can move on to sounding out the other phonemes in the word. However, a child who has a deficient PM may start to sound out the phonemes in the second syllable of the word if the first few phonemes were forgotten. For these reasons, PM plays a vital role in identifying children with reading difficulties.

6.3.3 Rapid Automatised Naming

Performance on RAN digits was found to be a strong predictor of reading efficiency in English. Wagner and Torgesen (1987) argued that RAN performance is primarily linked to reading because of its phonological aspects. Since RAN digits task performance is a good predictor of reading efficiency, low RAN task performance is associated with slower reading, and high RAN task performance is associated with faster reading (Bowers, 1993; Clayton et al., 2020; Houlis et al., 2019; Young & Bowers, 1995). In the current research, RAN digits performance was a good predictor of reading efficiency for monolingual Arabic-speaking

children, according to the regression results. These findings corroborate those of previous research that have suggested that RAN performance is a strong predictor of reading efficiency (Arnell et al., 2009; Babayiit & Stainthorp, 2011; Lervåg & Hulme, 2009; Park & Lombardino, 2013). In monolingual children, RAN performance did not contribute to reading accuracy in Arabic; it only predicted reading efficiency. Both reading and RAN are closely connected because they both depend on the ability to quickly and efficiently access and retrieve information from long-term memory (Wagner & Torgesen, 1987).

Several possibilities exist to explain why the children performed the RAN letters and digits processes more slowly in Arabic than in English. One possible explanation is that the grapheme-to-phoneme conversion may be slower in Arabic because Arabic letters contain many visual complexities, such as different shapes for one letter (e.g. Abdelhadi et al., 2011; Assad & Eviatar, 2013; Eviatar et al. (2004). Even when the words appear with diacritical markings, learning to read the Arabic language is challenging (e.g. Saiegh-Haddad & Joshi, 2014; Saiegh-Haddad & Lina, 2018). As noted previously, Arabic speakers who read Arabic text are reading a language that is somewhat different from the one they speak, so they are likely to read at a slower speed; this suggests that the greater the orthographic complexity, the slower the reading speed. The finding that RAN did not contribute to Arabic reading ability may be limited to a certain extent to bilingual children are exposed less frequently to the Arabic language, in addition to their weak knowledge of Arabic digits.

The current findings on the role of RAN digits task performance as a predictor of reading efficiency are also in line with the results of a previous study that indicated that RAN task performance is an important predictor of reading efficiency by demonstrating the role of RAN in reading efficiency in Arabic. Wimmer et al. (2000) suggested that RAN was the best predictor of reading efficiency in transparent orthographies. Moreover, PA is essential for reading accuracy at early ages, whereas RAN skills become more important as reading skills develop toward automaticity (Kirby et al., 2003; Moll et al., 2014; Wimmer et al., 2000). The current results agree with the findings of Ibrahim (2015), Saiegh-Haddad (2005), Layes et al. (2017) and Hassanein et al. (2022) that all RAN tests show an association with reading efficiency. Ibrahim's (2015) results revealed that RAN abilities were important for fluent reading in Arabic; in fact, he suggested including the RAN test in the assessment of Arabic reading skills. Hence, RAN skills should be considered for inclusion in all language assessments and in formal reading instruction because of its contribution to word reading efficiency.

6.4 The Inclusion of Tests of Phonological Processing in Reading Assessment

The current research has revealed some practical points for including tests of phonological processing in the assessment of bilinguals' reading skills. One such measure, PA, should be included in the assessment of the reading skills of both TD and RD bilinguals, and they must be assessed in both languages. The studies conducted as part of the current research project uncovered that the TD children exhibited greater PA than the RD children, but the two groups showed no significant difference in their performance on Arabic RAN digits tasks. Williams and Lovatt (2003) showed that PA is a significant precursor and a correlate to reading success. Torgesen (2000) noted that learning appropriate word reading skills is dependent on PM, which the author claimed is the first step in learning how to read.

Nevertheless, Arabic RAN task performance did not predict reading consistently, and it did not discriminate between the TD and RD groups, perhaps because the bilingual children were not very familiar with the Arabic digits. In some cases, PM testing may be inaccurate for L2 learners with less experience and less established language proficiency (Lipka et al., 2005). However, no differences in performance on memory tasks were observed between bilingual Arabic–English children in other research done that involved L2 learners (Abu-Rabia & Siegel, 2002). These findings suggest that the final test of phonological processing, PM, should not be included in reading assessments for bilingual Arabic–English children, as performance on PM tasks in Arabic failed to predict reading in Arabic.

Another possible reason for the difference in performance between languages is the lack of parity in tests across languages. Because of the lack of standardised tests in Arabic, the researcher adapted the English tests into Arabic, making every effort to ensure that the adapted tests were equivalent to the English versions by controlling the phonemes and the syllables for the words. All the words were vowelised because some of the children were in Grade 3 and had not yet started to read the un-vowelised text. Further, to reduce the ambiguity of the words so that the reader did not devote time to considering context to find the meaning of the words, which may reduce the reading fluency, all the words were formal Arabic terms; colloquial Arabic was not used.

Controlling the word frequency was difficult. The selected words were taken from sources that were likely to be familiar to the children; this may have affected reading performance in Arabic. Moreover, when adapting the test into Arabic, the researcher tried to control most of the words, but controlling for the digits was challenging, as was controlling for the syllables in the digits subtest, as Arabic numbers have more than one syllable. Arabic language

teachers checked all the words selected for adequacy. In addition, the researcher performed a statistical analysis to find the mean number of phonemes, syllables and characters in the English and Arabic versions to ensure that the adapted assessments of reading efficiency and reading accuracy were equivalent to the English versions.

6.5 The Diagnosis of Bilingual Children With Reading Difficulties

The KSA lacks formal assessments practices for identifying bilingual children with reading difficulties; children were referred to the current study who were classified as RD based on their nonverbal IQ and low achievement in literacy. The researcher administered the Arabic WISC-IV and the WASI in English; the results demonstrated that these children's profiles were consistent with the discrepancy model of reading difficulties (Hammill & Allen, 2020), with average IQs and low performance in reading skills and phonological skills. Likely, the discrepancy model is widely assumed to be prevalent in the KSA, although this is not explicitly stated in the literature on reading difficulties in the KSA.

The children in this study were bilingual, and most of the standardised assessment strategies were developed for use with monolingual populations, which may be one reason for the reported underestimation and often misdiagnosis of RD in bilingual children (Bedore & Peña, 2008; Usmani, 1999). Although some researchers (e.g. Deponio et al., 2000; Elbeheri et al., 2006) have considered this notion, most assessment strategies and tests still do not consider the cultural and linguistic differences of bi/multilingual children. Mahfoudhi (2009) suggested that an English assessment based on English norms was better than no assessment, but bilingual children must have some degree of English use for this assessment to work. In the current study, even if children were native Arabic speakers, their skills in both languages were assessed because they were taught in English and they have been exposed to English more than to Arabic.

Making an accurate assessment of reading difficulties is crucial to being able to provide necessary the identification, interventions and accommodations as early as possible (Geva & Wiener, 2015). A learning difficulty diagnosis cannot be established based on assessments of academic achievement, especially for bilingual students, because their academic performance may not accurately reflect their true abilities, possibly due to their restricted language proficiency and, in some cases, the student's education history or teaching quality instruction (Hale et al., 2010; Stuebing et al., 2008; Tannock, 2013). A limited number of standardised phonological processing tools are available in Arabic (Mahfoudhi et al., 2020).

The findings for the bilingual children with RD in Study 2 are also consistent with the phonological deficit hypothesis. In comparison with the TD children, the RD bilinguals showed a deficit in PA, PM and RAN (letters and digits) in both English and Arabic. Children at risk for RD have been found in many studies to have a deficit in their PA and RAN skills relative to those of their peers (Araújo & Faísca, 2019; Asadi & Shany, 2018; Capellini et al., 2008; Cronin, 2011; Deuschle & Cechella, 2009; Germano et al., 2008; Hornung et al., 2017; Justi & Cunha, 2016; Kirby et al., 2003; Kirby et al., 2010; Lima et al., 2008; Michalick-Triginelli & Cardoso-Martins, 2015; Norton et al., 2014; Peterson et al., 2017; Peterson & Pennington, 2012; Torppa et al., 2013; Wimmer et al., 2000; Wolf & Bowers, 1999). According to the phonological deficit theory, the most significant impediment to an RD individual's ability to acquire literacy is a lack of phonological awareness (Snowling, 1981). In keeping with this view, the current results indicated that PA was an important indicator of RD diagnoses for bilingual children for bilingual children with RD diagnoses. Additionally, the findings of this study indicate bilingual Arabic–English speakers may exhibit a pattern of reading-related skills that is consistent with Ramus and Szenkovits' (2008) claim that children with low PA skills will demonstrate weaknesses in their reading as a consequence.

The results of the phonological processing tasks showed that the RD children group performed worse compared to the TD group on PA tasks. This result is consistent with evidence that indicates that many RD children also have impaired PA abilities (Leather & Henry, 1994; Oakhill & Kyle, 2000; Share & Stanovich, 1995; Wagner et al., 1997). Learning to read is dependent on PA, and most agree that children with phonological difficulties will have reading problems (Snowling, 2001). This result is consistent with Baddeley and Wilson's (1993) findings that deficits in phonological processing form the basis for reading difficulties. It is also consistent with Snowling's (1998) view, which asserts that poor phonological knowledge is related to poor literacy (Abu-Rabia et al., 2003; Al Mannai & Everatt, 2005; Elbeheri & Everatt, 2007; Saiegh-Haddad & Geva, 2008; Smythe et al., 2008; Taibah & Haynes, 2010). In comparison to the biliterate TD children, the RD children showed a deficit in PA in both Arabic and English.

According to the double deficit hypothesis, children who have both PA and RAN skill deficits will be poorer readers than those who have only one phonological deficit (Bowers & Wolf, 1993). Moreover, Ibrahim (2015) discovered that RAN skills play a significant role in Arabic children's reading fluency levels. Furthermore, according to Gharaibeh et al. (2021),

the double deficit group had the lowest reading levels, followed by the group with a deficit in PA and then the RAN-deficit group. However, the low results of the TD bilingual and biliterate children on the Arabic RAN digits test in Study 1 made distinguishing the RD children's problems on the Arabic RAN test in Study 2 difficult. The current data do not support the double deficit hypothesis regarding Arabic–English bilingual children, but this may be because of problems associated with the Arabic RAN digits task used in this research, which was not well standardised against the English version (see section 3.7.3) and was performed more slowly than the English version by the TD bilinguals, especially in the UK.

Previous studies (Araújo & Faisca, 2019; Fawcett & Nicolson, 1994; McBride-Chang et al., 2011) have shown that RD children underperformed on RAN assessments, which is consistent with the findings from Study 2. Slower RAN processing was exhibited by those diagnosed as RD (Araújo & Faísca, 2019; Denckla & Rudel, 1976; Georgiou et al., 2018; Norton & Wolf, 2012). Prior research has also shown that RAN assessments can accurately differentiate between RD and TD readers (Araújo & Faísca, 2019), which is consistent with the English RAN results in the current research, as substantial differences were observed between the RD and TD children on the English RAN tasks. However, because the Arabic RAN digits performance of the RD children was not significantly different from the performance of the TD biliterate children, and because both groups completed the RAN tasks slowly, this outcome could not be generalised to the Arabic context.

Although PM did not predict Arabic reading skills in the TD children in Study 1 and only predicted English reading accuracy in Study 2, the performance of the RD differed from that of the biliterate TD children: specifically, the TD children outperformed the RD children on PM tasks. Reading has been claimed to be slowed by a lack of PM because the phonemes corresponding to graphemes are accessed slowly and fade quickly from memory (Gathercole & Baddeley, 1993). Although the inability to retain information, such as words, sentences or letters, in a sequential order is a primary characteristic of those who have RD (Frith, 1986), the consequences are slower acquisition of reading skills and failure of the reading process. In addition, poor PA skills in RD children can be caused by poor PM. For example, if children need to read the word '*hat*', the graphemes must be related to phonemes; therefore, PM allows the child to temporarily store sounds that they are attempting to remember using grapheme–phoneme correspondences. When compared to TD children, the RD children in this study had a deficiency in their PM. This finding is consistent with those of other researchers, such as Hulme and Mackenzie (1992) and Wagner and Muse (2006), who found

that the association between phonological short-term memory, PA and phonetic decoding of words is extremely strong.

6.6 Differences Across Languages and Countries

One unexpected finding from Study 1 was the difference in performance, not only across languages but also across countries. there was a significant effect of language on reading efficiency, PA and rapid letter naming, in which children performed better in English than Arabic, while there was no significant effect of language and countries on reading accuracy and PM. the difference in performance for the children in the UK and those in the KSA was much greater in English than it was in Arabic on the RAN digits test.

The possible reasons for this difference include differences in reading instruction quality and educational policy more generally across the two countries and for each language, as well as exposure to each language outside school and the structure of the Arabic language. Each is discussed in turn in the following sections.

6.6.1 Education System

The focus on one language at the expense of the other may have resulted in the pattern of effects that was observed in the reading skills of the bilingual children in the KSA in the current research, who performed better in English than in Arabic (Study 1). The bilingual education system in the KSA may not utilise the bilingual programme effectively, focusing too heavily on English at the expense of Arabic, considering the children in Study 1 and Study 2 attended bilingual schools. The school systems in some countries teach a minority language more predominantly than their majority language, as in the KSA (see section 3.4.1 for more details about the schools), yet both languages have been successfully acquired.

The establishment of an education programme for children at risk of academic failure due to poor skills in English, the language of schooling, in the United States, for example, was the catalyst for the bilingual education of minority language students (Genesee & Lindholm-Leary, 2008). Most of the U.S. English learners were Hispanic, and their families spoke Spanish as their primary language. The children in both the dual language (Spanish–English) programme and the monolingual (English) programme demonstrated equal improvement in PA and vocabulary in English, but the children in the bilingual programme also gained some Spanish language skills, demonstrating that dual language instruction did not limit the development of English, the L2. Language and literacy skills in both languages improve over time within bilingual education (Barnett et al., 2007). Accordingly, there is no indication that

bilingual education will have a negative impact on language development and literacy abilities in the majority language; furthermore, having the two languages available does help develop and preserve these abilities in the minority language.

The children in Study 1 demonstrated that monolingual schooling in the private schools in the KSA is effective; they were able to read well compared to the bilingual children attending the international school in the KSA. The bilingual children in Studies 1 and 3 who were in the KSA were in a difficult situation because they attended a bilingual school but did not appear to be receiving enough exposure to their L1 to support their developing reading proficiency in that language, as the monolingual children in Study 1 were able to read Arabic well. The bilingual school does not place a high priority on studying and mastering the Arabic language before moving on to the L2. Thus, coping with their L2 on one hand and understanding the structure of their L1 on the other gave them much to overcome. This may have impaired their ability to learn to read efficiently in Arabic. Possibly, the curriculum for bilingual students in the Arabic language does not cover the basic reading structure (Al-Jarf, 2007), or the teacher may not be aware of suitable methods for teaching Arabic.

Several scholars, including Alkhalifa (2004) and Aleasa (2009), have proposed that the Arabic curriculum in the KSA needs to be significantly revised, notably, in terms of its content, teaching techniques and administrative practices. The selection, development and organisation of syllabi content, learning materials, instructional methodologies and evaluation processes for the Arabic curriculum have traditionally been based on the whole language approach, which also needs to be revised. Therefore, the difficulties children had with reading in Arabic discovered in this research – specifically, that the bilingual children performed poorly on reading assessments in Arabic – are consistent with the recommendations of Alkhalifa (2004) and Aleasa (2009), although this outcome may simply reflect their lack of exposure to the Arabic language.

In addition to the lack of teacher training in Saudi Arabia, many teachers do not have the appropriate teaching resources to teach young children (OECD, 2021). Existing literacy materials do not guide instructors on how to assess the progress of students (Pastore & Andrade, 2019). At the same time, the method of literacy instruction varies from teacher to teacher, particularly in international schools. For example, the private schools in the current study (Schools D and E) followed the Ministry of Education system in the KSA: they taught all subjects in Arabic, only teaching English as a subject and not employing it as a medium of instruction; additionally, they focused more on teaching Islamic subjects, especially the

Quran, and they used the phonics method (Noorani Qaidah) to teach reading in Arabic (أباحسين et al., 2018). This may have been responsible for the monolingual children's ability to read in Arabic more quickly and more accurately than the bilingual children.

However, international schools in Saudi Arabia have the option of adopting either the British or American curriculum. As a result, in the international schools (Schools C, F, G and H) in the current studies, all topics were taught in English except Islamic studies and Arabic, which were taught in Arabic. Because the curricula these schools adopted, whether British or American, did not include instruction on how to teach Arabic or Islamic studies, the schools used different methods to teach reading skills, such as a whole language approach, whereas other international schools in other cities in the KSA used the phonics methods to teach reading. To the researcher's knowledge, no evidence has been published indicating which reading instruction methods have been employed in the KSA's private and international schools. The researcher gathered all information contained in this thesis related to reading instruction methods through observation and conversations with teachers in the schools. The children may have performed poorly on reading tasks in Arabic due to the inadequate reading instruction they received, but this cannot be confirmed because no data have been collected to identify the reading method through which the children are taught.

6.6.2 Exposure to the Language

According to the Home Languages Questionnaire administered, the bilingual children involved in this research appeared to have had more exposure to English than to their native language. Bilingual children who prefer to use English over their L1 may be at risk of losing their native tongue as English becomes their primary language (Köpke & Schmid, 2004). The process of losing a native or first language is known as language attrition (Schmid & Köpke, 2007), and several factors influence both language dominance and language attrition, one of which is education in the dominant language. According to Köpke and Genevska-Hanke (2018), the attrition and dominance of languages rely greatly on the language use of the immediate environment, and each can change quickly when the language environment changes. Furthermore, the attrition of an L1 is a phenomenon that only temporarily affects language processing skills, which can quickly return after re-exposure to the L1. Most of the children in Studies 1 and 3 attended an international school in the KSA, which they entered at the age of six. From Grade 1 onwards, English was the dominant language of instruction in these private schools; as a result, these children were exposed to English before they had

learned their native language (Arabic). The consequence of this is that their performance on Arabic reading skills was low.

The Study 1 results showed that biliterate children in the UK performed better on reading efficiency, PA and RAN letters in Arabic than those in the KSA. This may be because parents in the UK have more positive attitudes towards maintaining the use of Arabic than parents in the KSA. In the UK, the children at Saturday school (School B) attended a mainstream school during the week and on Saturdays attended an Arabic school that charged a fee for attendance, so their parents were paying for them solely to learn Arabic and Islamic studies. A family practice that promoted the learning of Arabic was allowing all children in every family to attend Arabic weekend schools to enhance the children's opportunities to learn Arabic language and literacy properly. Likewise, an increasing number of Arabic parents in the UK send their children to Arabic schools to learn formal Arabic and, especially, to acquire literacy (Szczepek Reed et al., 2020). Such parents are likely to have positive attitudes towards their heritage language and culture, which can lead to their acceptance of the responsibilities associated with maintaining and passing on the language and culture. Because of this, they are keen to teach their children their heritage language. Evidence has shown that an immigrant parent will appear to be influenced and motivated by their own linguistic perceptions and attitudes with regard to making judgments about foreign languages (Budiyana, 2017). Thus, the linguistic attitudes of immigrant families have a critical influence on the future status of the home language of immigrant children (Budiyana, 2017).

6.6.3 Structure of the Arabic Language for Bilingual Children

Arabic–English biliterate children performed worse than Arabic monolingual children on reading efficiency in Arabic. Their lower reading ability may be explained in a variety of ways related to the characteristics of the Arabic language: for example, the children may have taken longer to identify the letters, which differ significantly depending on their place in the word in Arabic. Some letters have a similar shape but a different name when the dots are placed over or under them. For example, the letter (ـنـ) has a similar shape but a different name when the dots are placed over or under it (see literature review in section 2.3.3). Children simply have more symbols to learn, and learning them involves a more complicated method, as their interpretation depends on where the letters are positioned in a word. Thus, the children may have taken a longer time to recognise the letters, particularly if they were unfamiliar with the Arabic text because of their limited exposure. They also were slower to

retrieve letter sounds due to weaker grapheme-to-phoneme conversion processes; for visually identical letters, retrieval of the letter name or sound in Arabic was slower than in English (Asaad & Eviatar, 2013). Hence, the conclusion can be drawn that the bilingual children had less exposure to Arabic and knew less about Arabic orthography, and they had difficulty coping with reading in Arabic.

Vowelised Arabic is orthographically shallow with nearly a one-to-one grapheme–phoneme correspondence. This is different from English, which is a much more opaque language. To accurately decode new words in English, relying on decoding word knowledge can be an appropriate strategy. As biliterate children are supposed to be literate in the two languages, they transfer their reading skills for decoding words more accurately between languages. According to the interdependence hypothesis noted by Cummins (1991), children who have already achieved literacy in one language will proceed faster in acquiring an L2 through the transfer of abilities (Cummins, 2000). In addition to reading skills in the L1, these positive impacts will only emerge if sufficient exposure to the L2 and the motivation to learn it both exist. Due to the small size of the selected biliterate sample, a regression analysis could not be performed to determine if their reading skills transferred from L1 to L2 or vice versa.

Arabic is completely different from English, and the TD biliterate children and RD children had been exposed to at least two versions of Arabic (Arabic standard form and spoken form) as well as English. Language learning is complex not only for RD children but also for TD children. A qualitative gap between the semantic, phonological and morphological skills of literary Arabic and spoken dialects has been reported (Maamouri, 1998; Saiegh-Haddad, 2003). Moreover, Saiegh-Haddad (2003) argued that the fluency of reading in Arabic can be affected by diglossia, as the diglossia essence of Arabic is intimately associated with the orthographic scope and word reading. Diglossia has been claimed to affect dyslexic children's reading ability by preventing them from having a strong phonological base as a foundation for orthographic learning (Schiff & Saiegh-Haddad, 2017). The difference between spoken Arabic and Standard Arabic may affect RD children, who may find reading words that are not in their spoken form challenging.

All the adapted Arabic assessments used in this study were written in Standard Arabic. It is possible that bilingual children have difficulty reading words with which they are not very familiar; for example, in the reading test, the word (استيقظ/ aistayqaz) means 'wake up', yet this word has a different dialect in spoken Arabic. Perhaps since monolingual children are more

exposed to Standard Arabic than bilingual children, they do not have as much difficulty reading this word as bilingual children do. Children in the KSA start to be exposed to Standard Arabic in Grade 1, where they find that the form of Arabic they speak every day is different from the one in which they must read and write. Switching between the formal and informal Arabic is believed to negatively impact a child's academic achievement, particularly regarding reading (Tibi et al., 2013). Standard Arabic is challenging for children to master, and the language gap may contribute to their delays in literacy because of the lack of a direct relationship between spoken and written Arabic (Asadi & Abu-Rabia, 2021; Khamis-Dakwar et al., 2012; Saiegh-Haddad & Lina, 2018). Learning to read in Arabic is difficult in general, and diglossia may account for some differences between languages.

6.7 Implications for Theory

These results provide a foundation on which researchers can develop further studies on the phonological processes in Arabic–English bilingual children, as well as in monolingual Arabic speakers. Predictive studies of bilingual children should incorporate measurements of different aspects of phonological processing, since this will provide a more comprehensive picture of their language strengths and deficits. This approach has already been carried out extensively in different languages (Lafrance & Gottardo, 2005; Wagner & Torgesen, 1987; Wagner et al., 1999), which helps us advance our understanding of the effect of phonological processing on cognitive and academic abilities for bilingual children.

6.8 Implications for Practice

Teachers and speech and language therapists in countries with high levels of immigration, such as the UK, must consider the early childhood language and literacy development of their pupils who are learning to read in English as an L2.

This study showed that when the children were taught reading based on phonics methods (English in international schools and Arabic in private schools), they performed better than those who were taught reading based on the whole language approach (Arabic in international schools). Furthermore, PA should be included in the assessment of reading skills of both TD and RD bilinguals, and they must be assessed in both languages. PA is associated with improved reading in both Arabic–English bilinguals and Arabic monolinguals. Both TD and RD children have been shown to benefit from PA training (Ehri et al., 2001). The practical conclusion that can be drawn from this study is that educators can create better interventions and instructional strategies for bilingual children according to their strong language proficiency. To plan for effective reading instruction, they should keep in

mind crucial aspects of reading, such as PA and RAN skill training (and the fact that limited evidence exists to indicate RAN training is an effective intervention for reading), and especially the relationship between phonemes and graphemes and how this differs between Arabic and English.

Bilingual education in the KSA needs to ensure that children have sufficient exposure to their L1 while at school, as the results in Study 1 showed that some of the biliterate children exhibited a low performance level in Arabic. There is a strong association between exposure to language and language acquisition. The Standard Arabic language should be taught to bilingual children in the KSA because it is the language that will be used to teach them how to read and write in Arabic. This is supported by research cited in this study (e.g. (Haddad, 2005; Saiegh-Haddad & Schiff, 2016) that determined greater exposure to the Standard Arabic language indicates higher reading efficiency and accuracy.

An additional point is that the final assessment (including diagnosis of reading difficulties) should consider the reading instruction that the child has received in both languages, as sometimes educators and parents assume a student's reading difficulties stem from their learning of a new language. If a child has problems reading in both languages, their L1 and L2, this may be a sign of dyslexia. This supports the recommendation that bilingual children should be assessed in each language individually rather than relying on one language to determine their reading skills and phonological processing skills.

Furthermore, teachers need to support the development of literacy in the L1, which will also help build literacy in the L2, as the biliterate children performed better in English than in Arabic on reading efficiency, PA and RAN skill assessments. This suggestion is based on the developmental interdependence hypothesis by Cummins (1979), who stated that how well bilingual children learn an L2 depends, in part, on how well they have learned their L1 at the time when intensive exposure to L2 begins.

The findings of this thesis also have implications for the development of practical tools to assess reading ability in Arabic. For example, teachers should use a variety of teaching reading strategies to help their biliterate children improve their reading accuracy, efficiency and phonological processing; for example, biliterate children performed poorly on RAN tasks in Arabic because they had less exposure to digits in Arabic. Teachers' use of different strategies to teach these children Arabic digits can impact their performance of RAN digits tests.

6.9 Limitations of the Present Study

The lack of standardised measures available for this study in Arabic in the KSA context was a significant limitation of this research. Even though the researcher adapted English standardised tests for use in Arabic, the RAN Arabic measures still need improvement. One of the most complicated aspects of this analysis was finding suitable word choices for the reading accuracy and efficiency tests. The researcher attempted to make the Arabic tests as equivalent to the English tests as possible. However, despite matching the phonemes and making some attempt to control for the length of the syllables, controlling for all variables known to influence word reading accuracy and efficiency, such as word frequency, proved to be difficult. Moreover, the findings indicate that the Arabic–English bilingual children performed worse on their RAN digits assessment in Arabic because of less exposure to the RAN digits in Arabic.

The second limitation is that the scores on the reading accuracy test, especially in English, were near the ceiling (Study 1). This suggests the test may not have been standardised properly or that the norms were outdated.

Another important limitation of this study is that no data were available on the specific instructional methods used by teachers to teach reading in either Arabic or English. Observation was the basis for reading instruction given in this research (Studies 1and 2). Children's phonological processing and word reading can both be impacted by instructional reading strategies.

The study included children ranging in socioeconomic status from wealthy (bilingual children in an international school in the KSA) to middle class (bilingual children in the UK and monolingual children in a private school in the KSA). Thus, generalising the results to other Arab backgrounds must be done with caution and only after controlling for background factors, such as socioeconomic level.

There were limitations associated with the Home Languages Questionnaire, which was kept short so that children would find it acceptable. As a result, a lack of sufficiently detailed information about Arabic and English reading experience was obtained. In order to get complete and reliable information from the Home Languages Questionnaire, it would be beneficial for the researcher to develop a questionnaire with more detailed questions and to test the reliability of that questionnaire or to use a more wide-ranging established questionnaire.

Finally, the RD children and TD children were not matched for IQ, as the TD children were not assessed for their IQ. As a result, the verbal and nonverbal abilities of the TD bilingual children could not be compared to those of the bilingual RD children. However, the RD children were within the normal range for both verbal and nonverbal IQ. For example, according to the discrepancy definition of dyslexia, in the absence of exclusionary criteria, RD is defined as reading at a level that is significantly below the expected reading level (see section 2.4).

6.10 Future Directions

For future studies, bilingual standardised Arabic–English reading tests and phonological processing skill assessments should be created that are more suitable for the Arabic–English bilingual context. The results of this research demonstrate the urgent need for the development of tests to assess reading and reading-related skills for Arabic–English bilingual learners, since few studies (Abu-Rabia & Siegel, 2002; Saiegh-Haddad & Geva, 2007) have used the reading skills and phonological processing skills measures for an Arabic–English sample.

Most research has focused on monolingual children's Arabic reading and language development. The reading development in Arabic in monolingual and bilingual children is a complex issue; despite the fact that only a few studies have focused on early reading development in Arabic, the limited evidence available highlights the benefits of early intervention (Gharaibeh, 2021) to enhance reading skills in children studying Arabic as their L1 who are struggling. The evaluation of existing research on the emergence of language studies, the assessment of the impact of an L2 on the development of reading in Arabic, and exploration of the significant role of phonological processing abilities in the pre-school years are all possible future study objectives.

The completion of intervention studies will additionally highlight the functions of PA and RAN skills, especially as intervention research on Arabic reading is limited. An obvious implication of the results of the present research is that intervention research with an emphasis on PA training is of primary importance because PA is a core skill underlying reading development in Arabic. Phonics-based methods have also been shown to be most effective in other languages. The impact of PA on children's reading across different grade levels should be studied as well.

Additionally, teachers who work with Arabic–English bilingual children should have a basic understanding of the linguistic characteristics of their students' L1 to understand their language knowledge and development, especially the mapping of sounds to letters in their L2 language and the specific complexities of both Arabic and English. Training programmes for teachers may, therefore, be needed in this regard. Teachers should be aware that literacy abilities are also transferable across languages. This has a major impact on a child's ability to master literacy in both their L1 and L2 (Abu-Rabia & Siegel, 2002; Saiegh-Haddad & Geva, 2008).

To discover whatever adjustments are required to make Saudi education more effective, additional study is required. Research should also examine education from a variety of angles, including the curricula, assessment methods and teachers, to promote the children's reading skills. Additionally, more bilingual education training programmes for teachers are needed to help educators utilise better pedagogical approaches that result in better learning outcomes for bilingual children and that facilitate the cross-linguistic transfer of phonological processing skills. Also important is the assessment of bilingual children's reading skills in both languages to provide an accurate evaluation of their development, stressing the importance of the transfer of literacy skills across languages.

6.11 Summary

The biliterate children subsequently selected who participated in this research performed better in English than in Arabic, except with respect to reading accuracy tasks, as no differences were observed between the selected biliterate children's performance on these tasks in the two languages. The results of this study also demonstrated that limited exposure to one or the other language affected the reading skills of biliterate children in that language. Although the vowelised Arabic is orthographically shallow, its characteristics challenge students.

Bilingual education is not harmful to reading development per se, but in this context, when one language enjoys much more exposure and a higher status, proficiency in the other language suffers. In some contexts, bilingual and biliterate education is very successful. These results illuminate the weakness of the instructional methods employed to teach reading to biliterate children in the KSA, which has implications for Saudi educational policymakers and authorities.

Finally, the RD bilingual children performed more poorly than the biliterate TD children on all phonological processing skill and reading skill assessments in both languages (Arabic and English) except the RAN digits test in Arabic, where no significant difference was observed

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Appendix 1

Reading Efficiency (words)

اختبار سرعة الكلمات

أنَّ	هَواء	حَيَوانَات	الكْترُونِيات
ظِل	سَكَنت	اسْتِراحَة	مَعلُومَاتِية
تِين	شَرِبَ	مِيزَانِيَة	إرشَادَات
دُود	مَبْروك	قَشْعَرِيرَة	مُستَهْلِكون
عَدَّ	رَسَمَت	مُعالِجين	طَمَأنِينَة
مَع	صَعِدَ	إصدَارات	إشعَاعَات
ثُمَّ	زَوجَة	مَغنَاطِيس	اضِطرَارية
كُل	بَارِد	اكْتَشَفَتها	مَسْؤولية
هُو	ثَعْلَب	مُنَاسَبات	نَمُوذَجية
ثَلج	سَفينَة	نِفَايَات	مُستَوِيين
رَأس	أظَافِر	رَاحَتِها	احتِفَالات
لَمَحَ	مَكَثوا	مُستَضْعَفَة	مِصْداقِيتَها
كَم	اسْتَأذَن	ارتِفَاعَات	مُختَرِعِون
فِيلْ	أهْدَاف	مَخْطُوطَات	استِراتِيجِيَة
لَهُ	مُمْطِرَة	مُهَنئين	مُتَحَاورين
كَتَبَت	حَدَثَ	مُنتَزَهَات	اسْتِنبَاط
عَسَل	تُفَاح	اتصَالات	مُستَعصِيَة
رَقَبَة	حَسْنَاوات	مُنحَدَرات	اسقَيناكُمُوه
قِردَة	مُحِيطَات	اخْتِبارات	
رَكَلَت	إعْلام	بُرتُقَالية	
خَرَجَت	قَفَزَت	مُنْحَدرات	
يَدِي	شَمعَدَان	أنْهَار	
شُكراً	مَدرَسَتي	اسْتَقْبَلتهُم	
قَمَر	أخْوات	مُواصَلات	
قَبِلَت	شَرِيكَة	خَمسِينِيَات	
ظَهَرَت	تَحْمِيني	مُتَواضِعَات	
لَعِبَت	مُحَاكاة	تِكنُولوجِيَا	
أكَلَت	فَرَاشَات	مُسْتَشرِقِين	
شَجَرَة	أطْفَال	دِيُمقْراطِية	
سَكَنَت	مَضْمُون	مُستَوحِشَة	

Reading Efficiency (nonwords)

اختبار سرعة الكلمات الغير حقيقية

رِم	كَمَرعَق	مُستَنسِبَة
مَم	سِتَابِح	بِيلانَدَور
لَر	نَقرَعم	قُوُرولاسَكَ
ثُو	فَلتَعَق	ايمُوبَلاتَا
سَش	يُغَربِع	شَخَمبَرتهُم
ظَو	شَمسَحَر	عَواِريظَنتُهم
تَب	صَخْمِن	
جَرَج	لَمَلعَت	
دَسَد	مِعَسْقَر	
لَبَح	فَحْرَب	
دَفَر	أَحمَزَت	
كَمَس	نَابِرَة	
سَرَأ	رَاحِمُوز	
مَعَل	أفدَافه	
مَتَرِع	طَارعِين	
جَثلَم	رَزعَلَم	
مِرنَد	بَطَبلَقر	
فَهرَض	ريخَرمو	
مَرسَد	خَايفرَم	
أضفَع	عُطنقَلَسم	
عَثرَق	تَتَحْرِدان	
زُعرُق	ماعتِنتَر	
خَثمَر	نَتواصِخَات	
قَفطَع	صَاروشَن	
سَمِخو	وارِفَنت	
قَّطعَج	طَمَأرينَسه	
عَقلَب	حَرَايَشَنت	
نَفحَرة	قِيمُقراطَة	
خَملسَم	اسْتَراتِيفَات	
مَارَطَب	سَوطَرتها	

Reading Accuracy (nonwords)

اختبار دقة الكلمات الغير حقيقية

أضَد	ثَفَر	سَرَأ	كَمَأ	تَقَز

سَمِيخ	تَنَب	ضَأرَم	دَعْدَع	جَثْلَم

لكَصَب	نَيتَرن	سَنطَرة	لخْلِيت	مَرسِيط
رِقظَار	طَلغَبَت	لطَافَاح	حَطَولَب	يَطْعَنيتُم

فَاتِخَانَه	تَابِزَات	رَافِبُوك	عَوارِيظُم	افْتراقَيتُوم
اخْتِسَامَات	نِثقَالتُوهُم	ضِرغَايض	غَصَاغِيرَها	مُشكَتِيفُوهَامُو

Reading Accuracy (Regular words)

اختبار دقة الكلمات

أب	مِن	كَسَر	قَرَأ	ذَهَبَ
أمَطَرَت	سَبَحَ	مُحِيطَات	ظِلال	زُهُور

فَرَاشَات	مَكتَبَتي	شَمعَدان	راحَتِها	مِجَلات
مُرتَفَعَات	عَمَالِقَة	استَأذَن	احْتِفَالات	غُزلان

بُرتُقَالية	مُنحَدرَات	مُحَاكاة	اختِبَارات	مَسْؤولياتُهم
مُستَوِيَيْن	استقْبَلتْهُما	مَعلُومَاتِية	استِراتِيجِية	مُستَهلِكَة

Phonological processing tests

اختبار العمليات الفونولوجية

Elision	الاجابة	اختبار حذف المقاطع والاصوات	
firshat asnan	اسنان	فرشاة أسنان.... بدون فرشاة	1
raei albaqar	راعي	راعي البقر....بدون البقر	2
faras alnahr	فرس	فرس النهر....بدون النهر	3
kurat sala	سلة	كرة سلة....بدون كرة	4
murakab shiraei	شراعي	مركب شراعي....بدون مركب	5
tayirat mirwahia	طائرة	طائرة مروحية....بدون مروحية	6
limun	مون	ليمون....بدون لي	7
fatira	يرة	فطيرة....بدون فط	8
ankabut	عنك	عنكبوت....بدون بوت	9
kas	أس	كأس....بدون ك	10
lahm	لح	لحم....بدون م	11
hadiqa	ديقة	حديقة....بدون ح	12
sami	ساي	سامي....بدون م	13
zahra	هرة	زهرة....بدون ز	14
qalb	لب	قلب....بدون ق	15
waqt	وق	وقت....بدون ت	16
lueba	لعة	لعبة....بدون ب	17
halzoun	حزون	حلزون....بدون ل	18
hashara	حرة	حشرة....بدون ش	19
shita	شاء	شتاء....بدون ت	20
badira	بارة	بادرة....بدون د	21
alwan	الان	ألوان....بدون و	22
namla	نمة	نملة....بدون ل	23
hayawan	حيان	حيوان....بدون و	24
sayaara	سياة	سيارة....بدون ر	25
eusfur	صفور	عصفور....بدون ع	26
tarikh	تايخ	تاريخ....بدون ر	27
atfal	اطال	أطفال....بدون ف	28
tayira	طائة	طائرة....بدون ر	29
mufassal	مصل	مفصل....بدون ف	30
mukhatita	خططة	مخططة....بدون م	31
saghira	صغية	صغيرة....بدون ر	32
mushkila	مشكة	مشكلة....بدون ل	33
maejun	معون	معجون....بدون ج	34

	تجميع الكلمة	الاجابة	Blending words
1	ماهي الكلمة التي تنتج من هذه الأصوات..رجل....المطافي	رجل المطافي	rajul almatafii
2	ماهي الكلمة التي تنتج من هذه الأصوات..حورية....البحر	حورية البحر	huriat albahr
3	ماهي الكلمة التي تنتج من هذه الأصوات..قلم....رصاص	قلم رصاص	qalam rasas
4	ماهي الكلمة التي تنتج من هذه الأصوات..لي....مون	ليمون	limun
5	ماهي الكلمة التي تنتج من هذه الأصوات...عص....فور	عصفور	ausfur
6	ماهي الكلمة التي تنتج من هذه الأصوات..أص....وات	أصوات	asawat
7	ماهي الكلمة التي تنتج من هذه الأصوات..أق..لا..م	أقلام	aqlam
8	ماهي الكلمة التي تنتج من هذه الأصوات..مط..ر..قة	مطرقة	mitraqa
9	ماهي الكلمة التي تنتج من هذه الأصوات..ش....مس	شمس	shams
10	ماهي الكلمة التي تنتج من هذه الأصوات..ذ....هب	ذهب	dhahab
11	ماهي الكلمة التي تنتج من هذه الأصوات..ن....عم	نعم	naeam
12	ماهي الكلمة التي تنتج من هذه الأصوات..ق....ط....ة	قطة	qita
13	ماهي الكلمة التي تنتج من هذه الأصوات..د...ب	دب	dub
14	ماهي الكلمة التي تنتج من هذه الأصوات..ق....بل	قبل	qabl
15	ماهي الكلمة التي تنتج من هذه الأصوات..س....ر	سر	sir
16	ماهي الكلمة التي تنتج من هذه الأصوات..مز....ح	مزح	mazah
17	ماهي الكلمة التي تنتج من هذه الأصوات..ن...هـ...ر	نهر	nahr
18	ماهي الكلمة التي تنتج من هذه الأصوات..ع...ظ....م	عظم	azum
19	ماهي الكلمة التي تنتج من هذه الأصوات..ج....م...ل	جمل	jamal
20	ماهي الكلمة التي تنتج من هذه الأصوات..ح...كا...ي...ـة	حكاية	hikaya
21	ماهي الكلمة التي تنتج من هذه الأصوات..ق....م...ر	قمر	qamar
22	ماهي الكلمة التي تنتج من هذه الأصوات..طا...ب...ع	طابع	tabie
23	ماهي الكلمة التي تنتج من هذه الأصوات..ن...ح...ل..ة	نحلة	nahla
24	ماهي الكلمة التي تنتج من هذه الأصوات..ي...ق...ف...ز	يقفز	yaqfiz
25	ماهي الكلمة التي تنتج من هذه الأصوات..ق..طا..ر	قطار	qitar
26	ماهي الكلمة التي تنتج من هذه الأصوات..غ...ي..م..ة	غيمة	ghayma
27	ماهي الكلمة التي تنتج من هذه الأصوات..ل...ذ..ي..ذ..ة	لذيذة	ladhidhatah
28	ماهي الكلمة التي تنتج من هذه الأصوات..ج..م..لة	جملة	jumla
29	ماهي الكلمة التي تنتج من هذه الأصوات..ا..ح..ت..فا..لا..ت	احتفالات	aihtifalat
30	ماهي الكلمة التي تنتج من هذه الأصوات..م..س..ت..ن..ك..ر..ة	مستنكرة	mustankira
31	ماهي الكلمة التي تنتج من هذه الأصوات..ي..ع..ب..ء...ها	يعبئها	yueabiuha
32	ماهي الكلمة التي تنتج من هذه الأصوات..إ..س..ت..ث..نا..ء	استثناء	iistethna
33	ماهي الكلمة التي تنتج من هذه الأصوات..اس..ت..را..تي...ج..ي..ة	استراتيجية	astiratijia

Phoneme isolation	عزل الفونيم	
dar	كلمة دار تحتوي على ثلاثة أصوات د-ا-ر ماهو الصوت الاول	1
ghayz	كلمة غيظ تحتوي على ثلاثة أصوات غ-ي-ظ ماهو الصوت الاول	2
saqr	كلمة صقر تحتوي على ثلاثة أصوات ص-ق-ر ماهو الصوت الاخير	3
ayin	كلمة عين تحتوي على ثلاثة أصوات ع-ي-ن ماهو الصوت الوسطي	4
qal	ماهو الصوت الأول في كلمة قال	5
dud	ماهو الصوت الأول في كلمة دود	6
nam	ماهو الصوت الأول في كلمة نام	7
khil	ماهو الصوت الأول في كلمة خيل	8
sayr	ماهو الصوت الأول في كلمة سير	9
khaf	ماهو الصوت الأخير في كلمة خاف	10
dun	ماهو الصوت الأخير في كلمة دون	11
ghazal	ماهو الصوت الأخير في كلمة غزال	12
safir	ماهو الصوت الأخير في كلمة سفير	13
manazil	ماهو الصوت الأخير في كلمة منازل	14
daqat	ماهو الصوت الوسط في كلمة ضاقت	15
yahij	ماهو الصوت الوسط في كلمة يهيج	16
qitar	ماهو الصوت الثاني في كلمة قطار	17
bitariq	ماهو الصوت الثاني في كلمة بطريق	18
sitiyn	ماهو الصوت الثاني في كلمة ستين	19
qalil	ماهو الصوت الثاني في كلمة قليل	20
tifla	ماهو الصوت الثالث في كلمة طفلة	21
akaltuha	ماهو الصوت الرابع في كلمة أكلتها	22
jazira	ماهو الصوت الثاني في كلمة جزيرة	23
ahwa	ماهو الصوت الثاني في كلمة أهواء	24
aistadhan	ماهو الصوت الثالث في كلمة استأذن	25
mumarida	ماهو الصوت الثالث في كلمة ممرضة	26
hanjara	ماهو الصوت الثالث في كلمة حنجرة	27
aijtimaeia	ماهو الصوت الثالث في كلمة اجتماعية	28
mubtahija	ماهو الصوت الرابع في كلمة مبتهجة	29
mustahlaka	ماهو الصوت الرابع في كلمة مستهلكة	30
adtirabat	ماهو الصوت الرابع في كلمة اضطرابات	31
zinatukum	ماهو الصوت الرابع في كلمة زينتكم	32

	تجميع الكلمات الغير حقيقية	Blending nonwords	
1	قا- ر	قار	gar
2	يا- عل	ياعل	yaeil
3	ما- طا	ماطا	mata
4	سو- تا	سوتا	Sutta
5	ني- نع	نينع	ninae
6	نح- خي	نحخي	nahkhi
7	را- خ	راخ	rak
8	فا- م	فام	fam
9	ك- م- ر	كمر	kamur
10	ع- ض- ق	عضق	eadaq
11	أ-ض	أض	add
12	ز- ط	زط	zat
13	خ- ف- ل	خفل	khafal
14	ر- م- س	رمس	rams
15	با- م	بام	bam
16	ن- ع	نع	nae
17	ط- ب- د	طبد	tabd
18	ض- ف-ق- ع	ضفقع	dafqae
19	ب- س- ح	بسح	bish
20	غ-ي-ل	غيل	ghyl
21	قي- ق-ة	قيقة	qiqah
22	ل- ب- س- م	لبسم	libasam
23	را-ش- ع	راشع	rashie
24	ر-ك-ن- ب	ركنب	ruknab
25	را- صا- في-ر	راصافير	rasafir
26	تا- م-ج	تامج	tamij
27	ما-ضا-ك-ر	ماضاكر	madakir
28	أ-ك-ن-س-ح-ت-و-ه-م	اكنسحتوهم	aknasahatuhum
29	تا-م-ك-ما-ر-ة	تامكمارة	tamikimara
30	ط-م-أ-ري- س- ة	طمأريسة	tamarisa

	تجزئة الكلمات الغير حقيقية	Segmenting nonwords
1	غس	ghss
2	يب	yb
3	ون	wn
4	كو	kw
5	نا	na
6	تر	tar
7	كج	kaj
8	رغ	ragh
9	ين	yan
10	رمشاع	rmshaa
11	يام	yam
12	شاض	shad
13	راف	raf
14	يانت	yanat
15	ماظ	math
16	درط	drt
17	تراست	terast
18	كرين	karen
19	بريخ	barek
20	ناحز	nahez
21	فوستام	fostam
22	متمري	metmery
23	رافيش	rafesh
24	تيمكاست	temakast
25	بابوكد	babokd
26	طرومباع	trombaa
27	باليقاش	baleyegash
28	بوزونترومان	bozontroman
29	سوشورنتازيم	suchorntazim
30	جيبادافرومبرن	Jepadafrombrin

	إعادة الأرقام من الذاكرة	Memory for Digits
1	٥-٢	
2	٧-٣	
3	٩-٧-١	
4	٦-١-٥	
5	١-٦	
6	٧-٢	
7	٩-٤	
8	٥-٢-١	
9	٦-٤-٨	
10	٨-٣-٦	
11	٥-٣-١-٨	
12	٣-٧-٤-١	
13	٧-٥-٩-٦	
14	٤-١-٨-٣-٩	
15	٦-٣-٢-٥-٨	
16	٩-٢-٤-٨-٣	
17	٨-٤-٩-٧-١-٣	
18	٦-٤-١-٣-٩-٧	
19	٤-٣-٨-٩-٧-٥	
20	٣-١-٩-٧-٤-٢-٦	
21	٩-٢-٥-١-٦-٣-٨	
22	٧-١-٤-٥-٢-٨-٣	
23	٤-٦-٣-٥-٩-٢-٧-١	
24	٩-٧-٤-١-٢-٥-٣-٦	
25	٤-٩-٢-٧-٣-١-٦-٥	
26	٩-٢-٨-١-٣-٧-٥-٤-٦	
27	٨-٢-٤-٧-٩-١-٣-٦-٥	
28	٤-٧-٥-١-٨-٢-٣-٦-٩	

Nonword Repetition	تكرار الكلمات الغير حقيقية	
gz	جز	1
ar	عر	2
raf	راف	3
qr	قر	4
rm	رم	5
ad	أض	6
basah	بسح	7
lisal	لصل	8
rashn	رشن	9
aiftaram	افترم	10
awtha	أوثاء	11
tamil	طمل	12
tiq	تيق	13
khikh	خيخ	14
zemqaa	زمقاع	15
tithqagh	تثقاغ	16
jawakhit	جواخيت	17
qasatayn	قصاطين	18
aiftisamar	افتسامار	19
murija	مورجة	20
mustankisa	مستنكصة	21
simasidasin	سيماسيداسين	22
kalakirtueankum	كالاكرتوعنكم	23
mushtastamuhum	مشتستموهم	24
rifaqtamanihulakum	رفاقتمنحولكم	25
jathmusadanikum	جاثموصدانكم	26
tastamluhatukum	تستملوحاتكم	27
sukanashafuhatiha	سكنشفهاتها	28
mashatmujatukum	مسحتموجاتكم	29
santarinkumuha	صنتارينكموها	30

RAN digits/الارقام

٢	٧	٤	٥	٣	٨	٤	٢	٥
٨	٣	٧	٢	٨	٤	٣	٥	٧
٤	٨	٢	٧	٥	٣	٥	٢	٨
٣	٤	٧	٣	٢	٥	٨	٧	٤

الاحرف /RAN letters

ش ص ت ش ك أ ن ت ص

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Appendix 2

Pilot Study

Mean, Standard Deviation (in parentheses), t-tests and p-values for Composite Scores for the Tests of Word Reading Efficiency, Diagnostic Test of Word Reading Processes and Comprehensive Test of Phonological Processing for Bilingual Children in Each Language

Test	English	Arabic	*t*	*p*
Reading efficiency (out of 174)	115.5 (15.59)	112.5 (15.42)	1.32	.24
Reading accuracy (out of 60)	54.0 (2.61)	53.83 (4.26)	.15	.88
PA (out of 160)	141.33 (8.14)	136.67 (4.08)	2.56	.05
PM (out of 58)	45.67 (4.08)	44.5 (2.95)	1.15	.30
RL time in second	13.83 (2.23)	12.33 (1.97)	4.39	.009
RD seconds per syllables	.31 (.05)	.28 (.06)	1.78	.13

Note. $N = 6$; standard deviations in parentheses. Due to the Bonferroni correction, the *p*-value should be $p < .008$ to be significant. PA = Phonological Awareness, PM = Phonological Memory, RD = Rapid Digit Naming, RL = Rapid Letter Naming.

Mean, Standard Deviation (in parentheses), t-tests and p-values for Composite Scores for the Tests of Word Reading Efficiency, Diagnostic Test of Word Reading Processes and Comprehensive Test of Phonological Processing for Bilingual Children and Monolingual children

Test	Group	Arabic	*t*	*p*
Reading efficiency (out of 174)	Bilingual	112.50 (15.42)	-.81	.44
	Monolingual	120.0 (15.03)		
Reading accuracy (out of 60)	Bilingual	53.83 (4.26)	-1.48	.17
	Monolingual	57.20 (3.03)		
PA (out of 160)	Bilingual	136.67 (7.74)	-.19	.85
	Monolingual	137.60 (8.59)		
PM (out of 58)	Bilingual	44.50 (2.95)	-.15	.89
	Monolingual	44.80 (3.83)		
RAN-L time in second	Bilingual	12.33 (1.97)	-.27	.79
	Monolingual	12.60 (1.14)		
RAN-D seconds per syllables	Bilingual	.28 (.06)	.33	.75
	Monolingual	.27 (.03)		

Note. Standard deviations in parentheses. Bilingual; *n* = 6 participants. Monolingual; *n* = 8 participants. PA = Phonological Awareness, PM = Phonological Memory, RAN-D = Rapid Digit Naming, RAN-L = Rapid Letter Naming.

Appendix 3

Pupil Language Questionnaire:

Name:		Initials	

Date of Birth	(date/ month/ year): / /
Place of birth:	City/ town: Country:
Number of years in UK	
Number of years learning English	

1. How many languages do you speak?.....

2. Which language did you learn to speak first? .....

3. What do you consider to be your first language? .....

4. How many languages do you speak at home? .....

5. What language(s) do you use when speaking to the following people (including English)?

0= Never 1=Rarely (1-30 % of the time) 2=Some (30-60 % of the time) 3=Most of the time (61- 90% of the time) 4=All of the time

	Language 1		Language 2		Language 3		Language 4	
Mother								
Father								
Siblings								
School friends								
Other friends								

6. How often do you speak English in the following situations?

0= Never 1=Rarely (1-30 % of the time) 2=Some (30-60 % of the time) 3=Most of the time (61- 90% of the time) 4=All of the time

Whilst having dinner with your immediate family (parents, brother, sister)	
When talking to your friends at school during break	
When talking with your friends outside of school	

Appendix 4

/University of Reading
Institute of Education
Risk Assessment Form for Research Activities February 2014

Select one:
Staff project: ☐ PGR project: ☑ MA/UG project: ☐

Name of applicant (s): Suhair Alhelfawi

Title of project: How do reading skills differ across languages in Arabic-English bilingual students?

Name of supervisor (for student projects): Dr.Holly Joseph and Dr.Daisy Powell

A: Please complete the form below

Brief outline of Work/activity:	I will use a standardised tool for assessing phonological skills (Comprehensive Test of Phonological Processing) (CTOPP 2), word reading efficiency (Test of Word Reading Efficiency; TOWRE 2) in English and Arabic and Diagnostic Test of Word Reading Processes (DTWRP). I will ask each child some questions about when they speak English and Arabic. Work one to one.

Where will data be collected?	Primary school. King Fahad Academy in London

Significant hazards:	None identified

Who might be exposed to hazards?	N/A

Existing control measures:	The rooms fall within the school's Health & safety responsibilities

Are risks adequately controlled:	Yes ☑ No ☐

If NO, list additional	Additional controls	Action by:

controls and actions required:		

B: SIGNATURE OF APPLICANT:

I have read the Heath and Safety booklet posted on Blackboard, and the guidelines overleaf.

I have declared all relevant information regarding my proposed project and confirm risks have been adequately assessed and will be minimized as far as possible during the course of the project.

Signed: … ……. Print Name: Suhair Alhelfawi Date 26/4/2016

STATEMENT OF APPROVAL TO BE COMPLETED BY SUPERVISOR (FOR UG AND MA STUDENTS) **OR** BY IOE ETHICS COMMITTEE REPRESENTATIVE (FOR PGR AND STAFF RESEARCH).

This project has been considered using agreed Institute procedures and is now approved.

Signed: Print Name Andy Kempe Date 24.5.16

* A decision to allow a project to proceed is not an expert assessment of its content or of the possible risks involved in the investigation, nor does it detract in any way from the ultimate responsibility which students/investigators must themselves have for these matters. Approval is granted on the basis of the information declared by the applicant.

University of Reading
Institute of Education
Ethical Approval Form A (version May 2015)

Tick one:
Staff project: PhD

Name of applicant (s): Suhair Alhelfawi

Title of project: How do reading skills differ across languages in Arabic-English bilingual students?

Name of supervisor (for student projects): Dr Holly Joseph and Dr Daisy Powell

Please complete the form below including relevant sections overleaf.

	YES	NO
Have you prepared an Information Sheet for participants and/or their parents/carers that:	✓	
a) explains the purpose(s) of the project	✓	
b) explains how they have been selected as potential participants	✓	
c) gives a full, fair and clear account of what will be asked of them and how the information that they provide will be used	✓	
d) makes clear that participation in the project is voluntary	✓	
e) explains the arrangements to allow participants to withdraw at any stage if they wish	✓	
f) explains the arrangements to ensure the confidentiality of any material collected during the project, including secure arrangements for its storage, retention and disposal	✓	
g) explains the arrangements for publishing the research results and, if confidentiality might be affected, for obtaining written consent for this	✓	
h) explains the arrangements for providing participants with the research results if they wish to have them	✓	
i) gives the name and designation of the member of staff with responsibility for the project together with contact details, including email . If any of the project investigators are students at the IoE, then this information must be included and their name provided	✓	
k) explains, where applicable, the arrangements for expenses and other payments to be made to the participants	✓	
j) includes a standard statement indicating the process of ethical review at the University undergone by the project, as follows: 'This project has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct'.	✓	
k)includes a standard statement regarding insurance: "The University has the appropriate insurances in place. Full details are available on request".	✓	
Please answer the following questions		
1) Will you provide participants involved in your research with all the information necessary to ensure that they are fully informed and not in any way deceived or misled as to the purpose(s) and nature of the research? (Please use the subheadings used in the example information sheets on blackboard to ensure this).	✓	
2) Will you seek written or other formal consent from all participants, if they are able to provide it, in addition to (1)?	✓	
3) Is there any risk that participants may experience physical or psychological distress in taking part in your research?		✓
4) Have you taken the online training modules in data protection and information security (which can be found here: http://www.reading.ac.uk/internal/imps/Staffpages/imps-training.aspx)?	✓	

5) Have you read the Health and Safety booklet (available on Blackboard) and completed a Risk Assessment Form to be included with this ethics application?	✓		
6) Does your research comply with the University's Code of Good Practice in Research?	✓		
	YES	NO	N.A.
7) If your research is taking place in a school, have you prepared an information sheet and consent form to gain the permission in writing of the head teacher or other relevant supervisory professional?	✓		
8) Has the data collector obtained satisfactory DBS clearance?	✓		
9) If your research involves working with children under the age of 16 (or those whose special educational needs mean they are unable to give informed consent), have you prepared an information sheet and consent form for parents/carers to seek permission in writing, or to give parents/carers the opportunity to decline consent?	✓		
10) If your research involves processing sensitive personal data[1], or if it involves audio/video recordings, have you obtained the explicit consent of participants/parents?			✓
11) If you are using a data processor to subcontract any part of your research, have you got a written contract with that contractor which (a) specifies that the contractor is required to act only on your instructions, and (b) provides for appropriate technical and organisational security measures to protect the data?			✓
12a) Does your research involve data collection outside the UK?		✓	
12b) If the answer to question 12a is "yes", does your research comply with the legal and ethical requirements for doing research in that country?			
13a) Does your research involve collecting data in a language other than English?	✓		
13b) If the answer to question 13a is "yes", please confirm that information sheets, consent forms, and research instruments, where appropriate, have been directly translated from the English versions submitted with this application.	✓		
14a. Does the proposed research involve children under the age of 5?		✓	
14b. If the answer to question 14a is "yes": My Head of School (or authorised Head of Department) has given details of the proposed research to the University's insurance officer, and the research will not proceed until I have confirmation that insurance cover is in place.			✓
If you have answered YES to Question 3, please complete Section B below			

Please complete **either** Section A **or** Section B and provide the details required in support of your application. Sign the form (Section C) then submit it with all relevant attachments (e.g. information sheets, consent forms, tests, questionnaires, interview schedules) to the Institute's Ethics Committee for consideration. Any missing information will result in the form being returned to you.

A: My research goes beyond the 'accepted custom and practice of teaching' but I consider that this project has **no** significant ethical implications. (Please tick the box.)	✓
Please state the total number of participants that will be involved in the project and give a breakdown of how many there are in each category e.g. teachers, parents, pupils etc. 30 Arabic-English speaking bilingual children from grade 4-6 will participate in this study.	

[1] Sensitive personal data consists of information relating to the racial or ethnic origin of a data subject, their political opinions, religious beliefs, trade union membership, sexual life, physical or mental health or condition, or criminal offences or record.

Give a brief description of the aims and the methods (participants, instruments and procedures) of the project in up to 200 words noting:

1. Title of project
2. purpose of project and its academic rationale
3. brief description of methods and measurements
4. participants: recruitment methods, number, age, gender, exclusion/inclusion criteria
5. consent and participant information arrangements, debriefing (attach forms where necessary)
6. a clear and concise statement of the ethical considerations raised by the project and how you intend to deal with then.
7. Estimated start date and duration of project

Title of the project:
How do reading skills differ across languages in Arabic-English bilingual students?

Purpose of project and its academic rationale:
This study will explore reading skills in Arabic-English bilingual students with a diagnosis of dyslexia of across both of their languages.

Brief description of methods and measurements:
All children with a known diagnosis of dyslexia in the schools recruited will be invited to take part. Participation in the study would involve seeing each child individually for two sessions. For the first session which consists of no longer than 30-40 minutes, each child will be asked to complete three short reading–related tasks: first, the Comprehensive Test of Phonological Processing (CTOPP), which will include; breaking words down into their individual sounds and matching sounds with letters. During the second task each child will be asked to read aloud a list of words and non-words (word which look and sound like words but aren't actually words); Test of Word Reading Efficiency (TOWRE-2) in English and Arabic. At the end of the first session, each child will be asked to read another list of words aloud, Diagnostic Test of Word Reading Processes (DTWRP). For the second session consisting of 20 minutes, each child will be asked to do non-verbal and verbal tests in English and Arabic (Wechsler Abbreviated Scale of Intelligence (WASI-ll). Also, the child may be asked some questions about when they use English and Arabic.

Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria:
Children will be recruited from the King's Fahd Academy in London. 30 Arabic-English bilingual children with dyslexia from grades 4-6 will take part in this study. These children will be identified by the school and letters will be sent home to parents of children known to have a diagnosis.

Consent and participant information arrangements, debriefing (attach forms where necessary)
The head teacher and the parent of the child will be sent a letter (see attachments Head teacher information sheet and Parent/carer information sheet) in which they will be fully informed about the purpose of the research, what taking part will entail, and how the results might be used. Parents will be given the opportunity to opt-out of the research project by returning a signed form (see attachment Parent/career consent form), which states that they do not want their child to take part. By using opt-out consent there is an increased chance of obtaining the highest number of student participants in the study. However, using opt-out consent means it is especially important that full consent of the parents is given and that the parents are fully aware of the content of the study and what it will entail and should they have any concerns or further questions then they can ask the researcher. In addition, I will ask each child individually whether they are happy to take part or not and I will give them an information sheet to read (see attachment Pupils information sheet). If they are not happy they will be reassured that they can withdraw at any time. All children will receive a small gift or sticker to thank them for their participation.

A clear and concise statement of the ethical considerations:
In the unlikely case that a child becomes tired or distressed, they will be offered a break. If they don't want to continue after this, they will be reassured that they can withdraw and it will have no effect on the schoolwork or anything else.

Estimated start date and duration of project:
To start from the end of May 2018 and it will take 2-school terms.

B: I consider that this project **may** have ethical implications that should be brought before the Institute's Ethics Committee.	

Please state the total number of participants that will be involved in the project and give a breakdown of how many there are in each category e.g. teachers, parents, pupils etc.
Give a brief description of the aims and the methods (participants, instruments and procedures) of the project in up to 200 words. 1. title of project 2. purpose of project and its academic rationale 3. brief description of methods and measurements 4. participants: recruitment methods, number, age, gender, exclusion/inclusion criteria 5. consent and participant information arrangements, debriefing (attach forms where necessary) 6. a clear and concise statement of the ethical considerations raised by the project and how you intend to deal with then. 7. estimated start date and duration of project

C: SIGNATURE OF APPLICANT:

Note: a signature is required. Typed names are not acceptable.

I have declared all relevant information regarding my proposed project and confirm that ethical good practice will be followed within the project.

Signed: … … Print Name: Suhair Alhelfawi Date: 17/5/2018

STATEMENT OF ETHICAL APPROVAL FOR PROPOSALS SUBMITTED TO THE INSTITUTE ETHICS COMMITTEE

This project has been considered using agreed Institute procedures and is now approved.

Signed: …… …… Print Name……Jill Porter Date…17/5/18….
(IoE Research Ethics Committee representative)*

* A decision to allow a project to proceed is not an expert assessment of its content or of the possible risks involved in the investigation, nor does it detract in any way from the ultimate responsibility which students/investigators must themselves have for these matters. Approval is granted on the basis of the information declared by the applicant.

University of Reading

Appendix 5

Head Teacher information sheet

Research Project: How do reading skills differ across languages in Arabic-English bilingual students?
Project Team Members: Suhair Alhelfawi (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)

Dear Head Teacher,
I am writing to invite your school to take part in a research study about reading skills in English and Arabic

What is the study?
This study will explore reading skills in Arabic-English bilingual students with a learning difficulty (Dyslexia). The intensity of the learning difficulty will be compared between the two languages within the same participant, especially the extent to which learning to read in one language might affect reading in other.
Why has this school been chosen to take part?
This school was chosen because you have canter of special Educational needs.

Does the school have to take part?
It is entirely up to you whether you give permission for the school to participate. You may also withdraw your consent to participation at any time during the project, without any repercussions to you, by contacting Suhair Alhelfawi by email: s.h.m.alhelfawi@pgr.reading.ac.uk
What will happen if the school takes part?
With your agreement, participation in the study would involve seeing each child individually for two sessions. For the first session which consists of no longer than 40-50 minutes each child will be asked to complete a number of short reading–related tasks, which will include: breaking words down into their individual sounds and matching sounds with letters, then each child will be asked to read aloud a list of words and non-words (word which look and sound like words but aren't actually words) in English and Arabic. At the end of the first session, each child will be asked to read another list of words aloud. For the second session consisting of 30 minutes, each child will be asked to do non-verbal and verbal tests in English and Arabic. Also, the child may be asked some questions about when they use English and Arabic. your child's responses will be audio recorded to ensure accuracy of scoring. I would also be very grateful if you could provide me with attainment records for the child (e.g. assessment report).
What are the risks and benefits of taking part?
There are no risks associated with taking part in the study. One possible benefit is the opportunity of one-to-one reading practice with an adult. If a child becomes tired or upset, he/she can withdraw from the study at any time.

What will happen to the data?

Any data collected will be held in strict confidence and no real names will be used in this study or in any subsequent publications. The records of this study will be kept private. No identifiers linking you, the children or the school to the study will be included in any sort of report that might be published. Participants will be assigned a number and will be referred to by that number in all records. Research records will be stored securely in a locked filing cabinet and on a password-protected computer and only the research team will have access to the records. The data will be destroyed securely once the findings of the study are written up, after five years. The results of the study may be presented at national and international conferences, and in written reports and articles. We can send you electronic copies of these publications if you wish.

What happens if I change my mind?

You can change your mind at any time without any repercussions. If you change your mind after data collection has ended, we will discard the school's data.

What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisor Dr Holly Joseph, University of Reading; h.joseph@reading.ac.uk

Where can I get more information?

If you would like more information, please contact Suhair Alhelfawi email: s.h.m.alhelfawi@pgr.reading.ac.uk

I do hope that you will agree to participate in the study. If you do, please complete the attached consent form and return it to Suhair Alhelfawi.

This project has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

Thank you for your time.

Yours sincerely,

Suhair Alhelfawi

<u>Head Teacher Consent Form</u>

I have read the Information Sheet about the project and received a copy of it.

I understand what the purpose of the project is and what is required of me. All my questions have been answered.

Name of Head Teacher: _____

Name of the school: _____

Please tick as appropriate:

I consent to the involvement of my school in the project as outlined in the Information Sheet ☐

Signed:_____

Date: _____

University of Reading

Appendix 6

Parent/carer information sheet

Research Project: How do reading skills differ across languages in Arabic-English bilingual students?
Project Team Members: Suhair Alhelfawi (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)
I am writing to invite your child to take part in a research study about reading skills in English and Arabic.

What is the study?

This study will explore reading skills in Arabic-English bilingual students. We know a lot about what makes a skilled reader in English but not so much about reading in other languages, especially the extent to which learning to read in one language might affect reading in other.

Why has my child been chosen to take part?

Your child has been invited to take part because he/she learns to read in both Arabic and English and is between the ages of 8 and 12.

Does my child have to take part?

It is up to you and your child to decide whether or not to take part. Giving permission is entirely voluntary. In this study we are using an "opt-out" policy such that all children will take part unless parents ask that they do not. If you do not want your child to take part, it is therefore essential that you complete the attached form and return it to your child's class teacher. We will not begin testing until at least a week after this letter is sent to allow you sufficient time to opt out. If you would like your child to take part, then you do not need to do anything. If you DO NOT want your child to take part, please fill in the following form attached and return it to your child's class teacher as soon as possible. If you decide to take part you and your child are still free to withdraw at any time and without giving a reason.

What will happen if my child takes part?

With your agreement, we would see your child at school. Each child needs to be seen individually for one session, for no longer than 30-40 minutes (unless there are any obstacles due to the school timetable in which case the session may have to be split). First, your child will be asked to complete a number of short reading–related tasks, which will include: breaking words down into their individual sounds and matching sounds with letters. During the second task your child will be asked to read aloud a list of words and non-words (word which look and sound like words but aren't actually words) in English and Arabic. For the last task your child will be asked to read another list of words aloud. Also, I will ask your child some questions about when they speak English and Arabic. Your child's responses will be audio recorded to ensure accuracy of scoring. I would also be very grateful if you could allow your child's schools to provide me with attainment records for your child (e.g. SATs results).

What are the risks and benefits of taking part?

There are no risks associated with taking part in the study. One possible benefit is the opportunity of one-to-one reading practice with an adult. If your child becomes tired or upset, he/she can withdraw from the study at any time.

What will happen to the data?
Any data collected will be held in strict confidence and no real names will be used in this study or in any subsequent publications. The records of this study will be kept private. No identifiers linking you, your child or the school to the study will be included in any report that might be published. Participants will be assigned a number and will be referred to by that number in all records. Research records will be stored securely in a locked filing cabinet and on a password-protected computer and only the research team will have access to the records. The data will be destroyed securely once the findings of the study are written up, after five years. The results of the study may be presented at national and international conferences, and in written reports and articles. We can send you electronic copies of these publications if you wish.

Who has reviewed the study?
This project has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct. The University has the appropriate insurances in place. Full details are available on request.

What happens if I/ my child change our mind?
You/your child can change your mind at any time without any repercussions. During the study, your child can stop completing the activities at any time. If you change your mind after data collection has ended, your child's data will be discarded.
What happens if something goes wrong?
In the unlikely case of concern or complaint, you can contact my supervisor Dr Holly Joseph, University of Reading; h.joseph@reading.ac.uk
Where can I get more information?
If you would like more information, please contact Suhair Alhelfawi, s.h.m.alhelfawi@pgr.reading.ac.uk
I do hope that you will agree to your child's participation in the study. If you **do not** want your child to participate, please complete the attached consent form and return it, sealed, in the envelope provided, to your child's teacher.

Thank you for your time.

Yours Sincerely,

Suhair Alhelfawi

Parent/Carer Consent Form

To be completed by a parent or guardian who **DOES NOT AGREE** to their child taking part in the study about: How do reading skills differ across languages in Arabic-English bilingual students?

Name of Researcher: Suhair Alhelfawi

Please tick as appropriate:

1. I confirm that I have read and understand the information sheet dated…… ☐
   For the above study and have had the opportunity to ask questions.
2. **I <u>DO NOT</u>** wish my child to take part in the above study. ☐
3. I **<u>DO NOT</u>** allow you to see my child's attainment records. ☐

_____

Your Name .....

Child's full name.....

Signature of Parent/Guardian……. Date of signature……..

Parental Opt-out Consent

Appendix 7

Pupils Information sheet

What Happens next

Your parents have been sent a letter asking for their permission for you to take part in this project.

I will check with you before I do the tasks that you are happy to help me with my project.

If you have any questions please speak to your class teacher. Or you can contact:

Suhair Alhelfawi

s.h.m.alhelfawi@pgr.reading.ac.uk

Research Teams:

Dr. Holly Joseph
Dr. Daisy Powell
Mrs. Suhair Alhelfawi

This project has been reviewed following the Procedures of the University of Reading Research Ethics Committee and has been given a favorable ethical opinion for conduct.

University of Reading

Institute of Education
London Road Campus
RG1 5EX

Pupils information sheet

Research Project

Do children read differently in English and Arabic?

Information Sheet

This study will look at how children with dyslexia who speak Arabic and English read in both languages. We are interested in whether reading difficulties are the same or different across the two languages

Why have I been invited to take part?

You have been invited to take part because you have dyslexia, you speak English and Arabic and you are between 8-12 years old.

Will anyone know about my answers?

Only the people working on the project will know about your answers. I won't tell your school how you answered, or your parents.

What will I have to do if I agree to take part?

I will see you at school on two days. The first day, I'll see you for 30-40 minutes during school time. I'll ask you to read some real words, some pretend words, and I'll ask you to tell me about the sounds that make up words. I'll ask you to do this in English and Arabic.

On the second day, I'll see you for 20 minutes, and ask you to match pictures and tell me about what some words mean. Also, I will ask you some questions about when you use English and Arabic at home and at school.

Will it help me if I take part?

I think you will find it interesting and fun to do the tasks. Your answers will help us to understand if you read differently in Arabic and English.

Do I have to take part?

No, not at all. Also, you can stop helping me with my study at any time, without giving a reason. Just ask me, your teacher or your parents to tell me if you want to stop.

Appendix 8

Cut-off Scores for Males in Reading English Regular Words

Age	*N*	*Mean* (*SD*)	Cut-off point
8	68	22.44 (6.20)	13
9	71	24.11 (6.34)	15
10	72	25.97 (3.90)	20
11	72	27.15 (3.02)	23
12	65	28.00 (2.21)	25

Note. *Mean* and *SD* reported above are taken from the DTWRP Manual, page 55 (Forum for Research in Literacy and Language, 2012). The cut-off for exclusion was based on the *mean* for the relevant age group – 1.5* *SD*.

Cut-off Scores for Females in Reading English Regular Words

Age	*N*	*Mean* (*SD*)	Cut-off point
8	71	21.30 (6.53)	11
9	72	25.19 (3.77)	19
10	68	25.57 (4.47)	18
11	68	27.25 (3.40)	22
12	69	28.28 (2.08)	25

Note. Mean and *SD* reported above are taken from the DTWRP Manual, page 55 (Forum for Research in Literacy and Language, 2012). The cut-off for exclusion is based on the *mean* – 1.5* *SD*.

Appendix 9

Cut-off Scores for Males and Females in Reading Arabic Regular Words (N = 79)

Age	*N*	*Mean* (*SD*)	Cut-off point
8	3	28.67 (2.31)	25
9	14	26.79 (4.76)	19
10	28	27.71 (3.52)	22
11	23	28.57 (2.23)	25
12	11	27.27 (5.22)	19

Note. *Mean* and *SD* reported above are taken from the monolingual cohort's regular word reading data obtained in Study 2. The cut-off for exclusion is based on the *mean* – 1.5* *SD*.

Appendix 10

Pearson Correlations for All English Subtests for Biliterate children (Study 1) N=34

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RAN-L	RAN-D
SWE	1	.55**	.20	.42*	.42*	.42*	.34*	.24	.34	.13	.26	-.53**	-.66**
PDE		1	.43*	.69**	.48**	.25	.11	.39*	.44**	.44**	.36*	-.56**	-.53**
NA			1	.51**	.29	.26	.21	.13	.14	.57**	.19	-.29	-.21
RA				1	.64**	.40*	.29	.15	.20	.35*	.24	-.45**	-.35*
EL					1	.53**	.30	.44**	.56**	.26	.16	-.38*	-.34*
BW						1	.42*	.53**	.43*	.28	.49**	-.46**	-.37*
PI							1	.29	.22	.36*	.43*	-.31	-.35*
BN								1	.66**	.45**	.42*	-.35*	-.52**
SN									1	.36*	.38*	-.42*	-.56**
MD										1	.34*	-.28	-.41*
NWR											1	-.28	-.33
RAN-L												1	.62**
RAN-D													1

**Correlation is significant at the .001 level. * Correlation is significant at the .05 level

SWE= Sight Word Efficiency, PDE= Phonemic Decoding Efficiency, NA= Nonwords Accuracy, RA= Regular Words Accuracy, EL= Elision, BW= Blending Words, PI= Phoneme Isolation, BN= Blending Nonwords, SN= Segmenting Nonwords, MD= Memory for Digits, NWR= Nonword Repetition, RAN-D= Rapid Digit Naming, RAN-L= Rapid Letter Naming.

Appendix 11

Pearson Correlations for All Arabic Subtests for Biliterate Children (Study 1) N= 34

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RAN-L	RAN-D
SWE	1	.71**	.51**	.59**	.21	.35*	.42*	.31	.37*	.13	.05	-.47**	-.58**
PDE		1	.59**	.56**	.19	.33	.31	.31	.25	.26	.11	-.32	-.39*
NA			1	.54**	.44**	.44**	.28	.27	.25	.28	.04	-.27	-.11
RA				1	.18	.31	.42*	.27	.37*	.09	-.00	-.21	-.49**
EL					1	.78**	.56**	.56**	.70**	.25	.21	-.28	-.09
BW						1	.53*	.55**	.76**	.10	.31	-.20	-.21
PI							1	.47**	.64**	.44**	.23	-.27	-.52**
BN								1	.75**	.31	.51**	-.20	-.23
SN									1	.31	.35*	-.26	-.42*
MD										1	.21	-.24	-.15
NWR											1	-.16	-.09
RAN-L												1	.32
RAN-D													1

**Correlation is significant at the .001 level. * Correlation is significant at the .05 level

SWE= Sight Word Efficiency, PDE= Phonemic Decoding Efficiency, NA= Nonwords Accuracy, RA= Regular Words Accuracy, EL= Elision, BW= Blending Words, PI= Phoneme Isolation, BN= Blending Nonwords, SN= Segmenting Nonwords, MD= Memory for Digits, NWR= Nonword Repetition, RAN-D= Rapid Digit Naming, RAN-L= Rapid Letter Naming.

Appendix 12

Pearson Correlations for All English and Arabic Tests With Composite Scores for Reading Efficiency, Reading Accuracy, PA and PM, N=34

	English efficiency	Arabic efficiency	English accuracy	Arabic accuracy	English PA	Arabic PA	English PM	Arabic PM
English efficiency	1	.53**	.49**	.35*	.53**	.37*	.38*	.43*
Arabic efficiency		1	.32	.67**	.40*	.39*	.16	.17
English accuracy			1	.39*	.39*	.18	.52**	.48**
Arabic accuracy				1	.41*	.44*	.03	.19
English PA					1	.67**	.57**	.62**
Arabic PA						1	.16	.43*
English PM							1	.76**
Arabic PM								1

**Correlation is significant at the .001 level. * Correlation is significant at the .05 level. PA= Phonological Awareness. PM= Phonological Memory.

Appendix 13

Pearson's Correlations for All Arabic Reading Efficiency, Reading Accuracy, PA, PM and RAN Subtests for Monolingual and Biliterate children (N=114)

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RL	RD
SWE	1	.91**	.80**	.79**	.71**	.67**	.72**	.74**	.75**	.28**	.71**	-.67**	-.73**
PDE		1	.83**	.80**	.72**	.67**	.73**	.74**	.74**	.31**	.72**	-.69**	-.70**
NA			1	.94**	.84**	.79**	.88**	.852**	.86**	.29**	.82**	-.70**	-.76**
RA				1	.83**	.77**	.85**	.84**	.85**	.32**	.81**	-.70**	-.75**
EL					1	.89**	.91**	.91**	.91**	.26**	.90**	-.63**	-.78**
BW						1	.86**	.87**	.89**	.21*	.86**	-.66**	-.74**
PI							1	.89**	.92**	.33**	.86**	-.71**	-.83**
BN								1	.95**	.24*	.92**	-.71**	-.83**
SN									1	.29**	.90**	-.71**	-.83**
MD										1	.21**	-.33**	-.24*
NWR											1	-.66**	-.78**
RD												1	.79**
RL													1

** Correlation is significant at the .001 level, * Correlation is significant at the .05 level. (*N*)= 114. SWE= Sight Word Efficiency, PDE= Phonemic Decoding Efficiency, NA= Nonwords Accuracy, RA= Regular Words Accuracy, EL= Elision, BW= Blending Words, PI= Phoneme Isolation, BN= Blending Nonwords, SN= Segmenting Nonwords, MD= Memory for Digits, NWR= Nonword Repetition= Rapid Digit Naming, RL= Rapid Letter Naming.

Pearson Correlations for All Arabic Tests for Monolingual and Biliterate children With Composite Scores for Reading Efficiency, Reading Accuracy, PA and PM, N=113 (Study 2)

	Arabic efficiency	Arabic accuracy	Arabic PA	Arabic PM
Arabic efficiency	1	.62**	.54**	.27**
Arabic accuracy		1	.62**	.39**
Arabic PA			1	.47**
Arabic PM				1

**Correlation is significant at the .001 level. * Correlation is significant at the .05 level. PA= Phonological Awareness. PM= Phonological Memory.

Appendix 14

Pearson Correlations for All English Subtests for RD Group (N= 28) (Study 2)

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RAN-L	RAN-D
SWE	1	.88**	.78**	.80**	.31	.49**	.42*	.57**	.59**	.62**	.50**	-.51**	-.39*
PDE		1	.69**	.78**	.13	.26	.29	.43*	.48**	.54**	.48**	-.46*	-.31
NA			1	.87**	.43*	.57**	.46*	.66**	.72**	.69**	.48**	-.52**	-.33
RA				1	.41*	.57**	.56**	.69**	.74**	.73**	.66**	-.49**	-.38*
EL					1	.79**	.79**	.79**	.79**	.65**	.52**	-.43*	-.44*
BW						1	.84**	.84**	.82**	.68**	.62**	-.50**	-.50**
PI							1	.85**	.75**	.65**	.64**	-.58**	-.55**
BN								1	.90**	.74**	.72**	-.57**	-.59**
SN									1	.84**	.68**	-.56**	-.59**
MD										1	.64**	-.69**	-.63**
NWR											1	-.55**	-.63**
RAN-D												1	.80**
RAN-L													1

** Correlation is significant at the .001 level, * Correlation is significant at the .05 level. SWE= Sight Word Efficiency, PDE= Phonemic Decoding Efficiency, NA= Nonwords Accuracy, RA= Regular Words Accuracy, EL= Elision, BW= Blending Words, PI= Phoneme Isolation, BN= Blending Nonwords, SN= Segmenting Nonwords, MD= Memory for Digits, NWR= Nonword Repetition, RAN-D = Rapid Digit Naming, RAN-L= Rapid Letter Naming.

Pearson Correlations for All Arabic Subtests for RD Group (N= 28) (Study 2)

	SWE	PDE	NA	RA	EL	BW	PI	BN	SN	MD	NWR	RL	RD
SWE	1	.69**	.82**	.85**	.49**	.42*	.59**	.51**	.64**	.37*	.45*	-.56**	-.48**
PDE		1	.65**	.62**	.25	.28	.45*	.27	.32	.24	.43*	-.51**	-.44*
NA			1	.92**	.54**	.52**	.61**	.66**	.76**	.52**	.62**	-.59**	-.38*
RA				1	.56**	.51**	.55**	.67**	.76**	.51**	.53**	-.56**	-.39*
EL					1	.88**	.77**	.78**	.79**	.29	.74**	-.44*	-.34
BW						1	.78**	.85**	.76**	.33	.82**	-.36	-.23
PI							1	.77**	.75**	.45*	.79**	-.57**	-.53**
BN								1	.93**	.38*	.82**	-.42*	-.23
SN									1	.43*	.74**	-.45*	-.30
MD										1	.41*	-.39*	-.28
NWR											1	-.58**	-.36
RD												1	.72**
RL													1

** Correlation is significant at the .001 level, * Correlation is significant at the .05 level. SWE= Sight Word Efficiency, PDE= Phonemic Decoding Efficiency, NA= Nonwords Accuracy, RA= Regular Words Accuracy, EL= Elision, BW= Blending Words, PI= Phoneme Isolation, BN= Blending Nonwords, SN= Segmenting Nonwords, MD= Memory for Digits, NWR= Nonword Repetition, RAN-D = Rapid Digit Naming, RAN-L= Rapid Letter Naming.

Appendix 15

Pearson Correlations for All English and Arabic Tests With Composite Scores for Reading Efficiency, Reading Accuracy, PA and PM, N=28 (Study 2)

	English efficiency	Arabic efficiency	English accuracy	Arabic accuracy	English PA	Arabic PA	English PM	Arabic PM
English efficiency	1	.38*	.82**	.59*	.45*	.38**	.62**	.55**
Arabic efficiency		1	.59**	.83**	.47*	.51**	.54**	.50**
English accuracy			1	.81**	.64**	.55**	.73**	.67**
Arabic accuracy				1	.69**	.68**	.73**	.67**
English PA					1	.90**	.80**	.83**
Arabic PA						1	.68**	.78**
English PM							1	.86**
Arabic PM								1

**Correlation is significant at the .001 level. * Correlation is significant at the .05 level. PA= Phonological Awareness, PM= Phonological Memory, RAN-D= Rapid Digit Naming, RAN-L= Rapid Letters.