The relationship between morphological awareness and word reading among typically developing children and children with reading difficulties attending bilingual (Arabic-English) schools in Kuwait

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Declaration

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

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Abstract

Morphological awareness (MA) has been shown to be an important linguistic skill in both Arabic and English monolingual readers (Breadmore et al., 2021; Saiegh-Haddad, 2018). The first aim (Study 1) of the research was to examine the relationship between MA and word reading among typically developing (TD) students and students with a reading difficulty (RD) in the 4th and 5th grade attending bilingual (Arabic-English) schools in Kuwait (N = 53). The second aim (Study 2) was to examine Arabic word reading (voweled and unvoweled), phonological processing, and MA among students with RD attending bilingual and monolingual schools (N = 40). This research contributes to knowledge by providing an understanding of the role of MA in English and Arabic among biliterate students with and without RD and whether schooling (monolingual vs. bilingual) had an influence on students with RD.

MA was measured using judgement and analogy tasks administered in the written and oral modality focusing on derivational morphology only. Results of Study 1 demonstrated that the students with RD showed deficits in phonological processing, MA, and word reading skills in both English and Arabic when compared with the age-matched TD controls, with the exception of Arabic rapid automatized naming (RAN) scores. MA was significantly related to English exception word reading among TD children only. MA was significantly related to Arabic nonword reading accuracy, among TD children, and Arabic voweled reading accuracy and nonword reading fluency, among RD children. Results of Study 2 showed no significant differences between students attending bilingual schools and those attending monolingual schools in phonological processing, MA, and word reading, though there was a significant difference in reading accuracy which showed higher scores for students attending monolingual schools.

The results demonstrated the importance of MA in both Arabic and English word reading among biliterate children. These findings also show that there is no harm for children with RD in learning an additional language.

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1. Introduction

The ability to read and write, also known as literacy, has been shown to have wide-ranging influences on children's academic success as well as their future social status, job opportunities, and financial success (Irwin et al., 2007). However, approximately 15% of people internationally suffer from word reading difficulties (Reid, 2016). Children with reading difficulties (RD) are heterogeneous, and educators need to tailor support to the specific needs and characteristics of the child (Reid, 2016). Therefore, it is important to research children's reading development to understand different profiles of strengths and weaknesses that can exist in children to understand better the compensatory mechanisms that children with RD might use.

Reading development has been extensively researched and certain skills, such as phonological awareness (PA) are important to understand when examining reading. PA refers to the awareness of the sound structure of oral language, and the ability to explicitly segment or blend these sound structures (Hulme et al., 2005; Mattingly, 1972). It has been established that there is a strong relationship between PA and reading acquisition (Ball & Blachman, 1988; Fox & Routh, 1984; Tunmer et al., 1988; Wagner & Torgesen, 1987), and it has been argued that PA is the strongest predictor of reading skills in the early stages of reading (Adams, 1990). However, a skill known as morphological awareness (MA) has been identified as an important skill that has been largely missing from previous theories of reading (Levesque et al., 2021; Saiegh-Haddad, 2018), and is especially important when learning to read in English and Arabic. Morphological awareness (MA) refers to the awareness of morphemes (smallest units of meaning in a word) in spoken language and the ability to think about and manipulate these morphemes (Carlisle, 2000). Another reason the current study focuses on MA is that it has also been argued that some children with RD use this skill when reading to compensate for their weakness in PA (Cavalli et al., 2017; Saiegh-Haddad & Taha, 2017).

Due to globalization, people often benefit from being competent in two languages (Genesee & Fortune, 2014). Not enough research, especially in the Middle East, compares the influence of monolingual and bilingual education on children with RD. When a child is diagnosed with RD, parents often wonder whether it is best for their child to attend a monolingual school and focus on learning to read in one language or whether the child may benefit from attending a bilingual school and learn to read (and speak) in two languages. To make an informed decision about what is best for their child, it is crucial that parents have evidence-based information on the benefits and challenges of bilingual education for children with RD. If children with RD do not attend programs that include second-language learning, then they may miss out on the opportunity to benefit from that language on a personal and professional level (Genesee & Fortune, 2014). Also, exposure to a second language may benefit these children's reading skills due to the transfer of linguistic skills across languages (Cummins, 1978, 1979). Therefore, it is important to research the benefits and challenges of learning to read in two languages especially for children who struggle with literacy, which is an aim of the current study. Research related to RD and bilingual education can also highlight what aspects of assessment, teaching, and intervention practices are needed to help these children. Since this research was carried out in Kuwait, the next section elaborates on the educational system in Kuwait and sets the context for the study.

1.2. Kuwaiti Context

The population of Kuwait is approximately 4.8 million, and 32% are Kuwaiti citizens while 68% are non-Kuwaiti citizens of which a large proportion come from Egypt and India (Central Statistical Bureau, 2023). The Arabic-speaking citizens, including both Kuwaiti citizens and non-Kuwaiti citizens, make up 60% of the population (The Public Authority for Civil Information, 2023). In the academic year 2021/2022, there was a total of approximately 680,000 students (37% attended private schools) enrolled in 1,238 schools in Kuwait (47% of which were private schools) (Central Statistical Bureau, 2022).

Children must start elementary school at the age of six, and this is usually preceded by two years of kindergarten, although kindergarten is not mandatory. In kindergarten, limited literacy instruction may begin (AI-Sulaihim, 2014). All schools in Kuwait are divided into three levels: elementary, middle school, and high school where each stage consists of four years. The curriculum for all schools includes the Arabic and English language, mathematics, science, arts, and the Holy Quran (Saiegh-Haddad & Everatt, 2017). Members of the population are able to access schools easily because all families live in urban areas (Hafsyan, 2023).

Kuwait had a low ranking compared to the countries assessed in the 2016 study of the Progress in International Reading and Literacy Study (PIRLS) indicating poor Arabic literacy levels in fourth grade children (International Association for the Evaluation of Educational Achievement, 2016). The World Bank defines the term 'learning poverty' to describe children who are attending regular schooling but are not learning important skills (World Bank, 2019), and has calculated a learning poverty rate based on the 2016 PIRLS results (International Association for the Evaluation of Educational Achievement, 2016). For example, in Kuwait, the learning poverty rate of 51% percent indicates that, by age 10, half of the children are not able to read and understand a passage in Arabic (World Bank, 2019). In comparison, the learning poverty rate in neighbouring countries, like Saudi Arabia, is 38%, and in Europe and Central Asia it is 13% (World Bank, 2019). Kuwait was also ranked below average in the Trends in International Mathematics and Science Study (TIMSS), which assesses children's learning levels on subjects such as Mathematics and Science in the fourth and eighth grade (not including private schools) (International Association for the Evaluation of Educational Achievement, 2019).

Some of the reasons behind the low performance in Arabic literacy skills in Kuwait has been argued to be related to time dedicated to teaching literacy in schools as well as the home literacy environment (Gregory et al., 2021). The PIRLS has indicated that Kuwait is among the countries that have scored below average for the time dedicated to teaching Arabic language in both public and private schools (International Association for the Evaluation of Educational Achievement, 2016). The PIRLS also revealed through their parent responses that only 20% of children are being read to by their parents in Kuwait (International Association for the Evaluation of Educational Achievement, 2016). Research has shown that the home literacy environment is significantly related to children's reading development (Korat et al., 2014) and that being read to as children helps them transition better in the early years of school instruction (Stahl et al., 1990). Gregory et al. (2021) argue that the reason behind the low percentage of children being read to could be that reading to children in the Middle East region has not been part of the culture and parents are not aware of the benefits. A study has shown that Kuwaiti mothers with higher levels of education tend to engage more in activities like reading to their child (Alshatti et al., 2020). Another aspect of countries in this region is that many children are taken care of by foreign nannies and so exposure to the Arabic dialect and Arabic children's books is reduced (Gregory et al., 2021). The next section details the differences between public and private schools in Kuwait and highlights additional reasons that are argued to be contributing to low levels of literacy in Kuwait.

1.2.1. Public Schools

Most public schools are gender segregated starting from the first grade. Public schools are free for Kuwaiti citizens who make up 85% of the student population, and non-Kuwaiti citizens are not allowed to attend public schools, with a few exceptions (Central Statistical Bureau, 2022). Public schools are supervised by the Ministry of Education, which is responsible for setting the curriculum, writing textbooks to be taught as subjects, planning, strategy, and monitoring new policies (Saiegh-Haddad & Everatt, 2017). Children start studying English in public schools in the second grade, but most of the school instruction is in Arabic. Examinations based on learning criteria set by the ministry must be passed by students to progress to the next level (Saiegh-Haddad & Everatt, 2017). These examinations are based on the content included in the ministry textbooks.

In 2008, investments were made to develop the public education system in Kuwait and efforts to make education compulsory were increased (State of Kuwait General Secretary of the Supreme Council for Planning and Development, 2010). However, as seen in the international assessment results reported in the previous section, these efforts have not been effective. Saiegh-Haddad and Everatt (2017) argue that weaknesses in the public education system in Kuwait were due to a curriculum that is focused on whole-word reading strategies. Starting from the third grade onwards, the focus shifts to teaching the rules of grammar, vocabulary, and reading comprehension because that is the focus of the curriculum and the examinations at the end of elementary school to progress to the next educational level (Saiegh-Haddad & Everatt, 2017). Researchers have argued about how children should be taught how to read (Kim, 2008). Whole-word reading strategies teach children how to read by guessing using skills accumulated through experience (Goodman, 1967) while a phonics approach explicitly teaches children how to associate letters with the sounds in words (Flesch, 1955). Systematic phonics instruction teaches children the relationship between letters and sounds in a specific order, and the synthetic approach teaches them how to blend these sounds to pronounce words (Castles et al., 2018). It has been recognized in Kuwait that the phonics approach is important, and attempts were made to incorporate it in the reading material in the first grade and later grades (Saiegh-Haddad & Everatt, 2017). However, it has been argued that phonics-based instruction has been misunderstood and unsuccessful in the region because of the history of the use of the whole-word approach and because teachers themselves have not mastered the concept of phonics (Saiegh-Haddad & Everatt, 2017). Teacher preparation courses in the region do not include phonics training (United States Agency for International Development, 2019).

Saiegh-Haddad and Everatt (2017) also argue that weaknesses in the public education system in Kuwait have been linked to low standards in teacher training (Al-Sharaf, 2006;

Ayoub, 2012; Burney & Mohammed, 2002). Teacher training focuses on theories with very little practical training, and the teacher's focus in the classroom is to cover the content included in ministry textbooks to prepare for examinations rather than teaching the lesson by involving the students (Saiegh-Haddad & Everatt, 2017). Kuwaiti citizens make up around 20% of the teaching work force as the teaching profession is not valued in the culture (Al-Sharaf, 2006; Ayoub, 2012). Therefore, teachers are employed from other Arabic-speaking countries, and the criteria for employment in Kuwait is not very strict (Al-Sharaf, 2006; Ayoub, 2012).

In addition to these general limitations in teacher training, there is a specific limitation in relation to teacher expertise in special educational needs (Al-Manabri et al., 2013). Although there have been increased efforts to raise teachers' experience with children with special educational needs, teachers mostly learn about children with special educational needs theoretically but have minimal practical training and experiences with them (Elbeheri & Everatt, 2011). There is evidence of a shortage of trained professionals in the area of special educational needs in Kuwait and the Arab region (Alquraini, 2011; Gaad, 2011). Specialists employed in public mainstream classes to support children with special educational needs are scarce (Al-Mousa, 2010). However, during examinations, the law requires that the public schools provide provisions for a student diagnosed with a learning difficulty (LD) (Minister of Education, 2016), which is considered by the Kuwaiti government as a sub-category of children with special educational needs. Schools must give the student extra time during exams, provide support in reading the exam questions, and provide support in writing responses to exam questions if the child suffers a severe writing difficulty. Kuwaiti citizens only, who have obtained an LD diagnosis from entities recognized by the government, have the right to apply for financial support with which the government will pay the tuition fees of private schools in full, or will pay the after-school tutoring fees for LD children registered in the public school system. Forms of LD recognized by the Public Authority of the Disabled (PAD) (2016) in Kuwait include dyslexia (reading difficulty), dysgraphia (writing difficulty), dyscalculia (difficulties in mathematics), dyspraxia (motor difficulties), and Attention Deficit Hyperactivity Disorder (ADHD). Not all reading difficulties equals dyslexia (Aaron, 1997), but these two terms are generally used interchangeably in Kuwait.

The International Monetary Fund has reported that although the Kuwaiti government spends a significant amount of money on the education sector (given it is a high-income country due to a large number of oil reserves), the quality of education is still poor and needs to be improved (International Monetary Fund, 2023). A national reform program was recently launched called ‘Vision 2035’ (Ministry of Foreign Affairs, n.d.), which includes plans to reform the education sector. The educational reform plans were created by the Ministry of Education, National Centre for Education Development and The World Bank calling it ‘School Education Quality Improvement 2’ (National Center for Educational Development, 2018). The program includes plans to reform the curriculum, increase the proportion of Kuwaiti teachers, improve teachers’ university curriculums and training, provide continuous professional development, and improve provision for children with special educational needs attending mainstream classes by supporting inclusion, the use of evidence-based practice, and the use of technology. A study that has examined public school elementary special needs teachers’ awareness and use of evidence-based practice in mainstream classrooms in Kuwait has shown positive results suggesting that efforts to improve special education teachers’ university curriculums and training as part of the national educational reforms might have had a positive influence (Al-Shammari & Mintz, 2022). However, the Kuwaiti Ministry of Education is still highly criticised (Alhouti, 2020). Alhouti (2020) argues that there is a lack of communication between leaders, Ministers of Education are frequently changed (because of the unstable political situation), and no follow-through takes place between one minister and the next. For example, despite the Ministry’s efforts to reform education and introduce an online platform since 2008 (Ministry of Education, 2008), none of these reforms or plans were implemented until the pandemic hit in 2020 (Alhouti, 2020). The Ministry of Education closed public schools in Kuwait in February 2020 and did not provide students with an online platform to learn until October 2020 leaving children at home with no form of learning for 8 months (with the exception of Grade 12 students who were provided the opportunity to complete the academic year online in June 2020). This scenario was not seen in most other countries where students were able to learn in some form throughout the pandemic (Alhouti, 2020). The next section describes the private schools in Kuwait.

1.2.2. Private Schools

Private schools were developed in Kuwait mostly to cater to the large proportion of the population that are non-Kuwaiti citizens, but are also attended by Kuwaiti citizens (Saiegh-Haddad & Everatt, 2017). Indeed, Kuwaiti citizens make up 30% of the students that attend private schools (Central Statistical Bureau, 2022). Private schools are also supervised by the Ministry of Education (Saiegh-Haddad & Everatt, 2017). Private schools may follow an Arabic, foreign language, or bilingual curriculum. Of the private schools, 73% are foreign language and bilingual schools while the remaining 27% are Arabic private schools (Central Statistical Bureau, 2022). The Arabic private schools follow the same curriculum as public schools. The breakdown of foreign language and bilingual schools include schools in which the curriculum is set by the ministries of certain countries such as American schools (9%), British schools (18%), Indian schools (28%), Pakistani schools (15%), and French schools (1%) with most of the school instruction carried out in the corresponding language (Central Statistical Bureau, 2022). In bilingual schools (28%), the proportion of time dedicated to Arabic language instruction is greater than in foreign language schools. The Arabic language and the Holy Quran curricula, prepared by the Ministry, must be included in all private schools.

Foreign and bilingual schools' curricula tend to be preferred by Kuwaiti parents over the highly critiqued public-school curriculum, discussed above, especially as some private schools are accredited by globally recognized international associations such as The New England Association of Schools and Colleges (NEASC). Wealthier Kuwaiti families tend to prefer private education rather than public education. However, this is not necessarily the case as other factors may influence their decision such as preference for gender-segregation as most private schools are not gender segregated. Other families may choose public over private education due to their preference of language of instruction. However, since non-Kuwaiti citizens have no choice but to attend private schools, these families can choose between the large range of private school fees available, as some schools are more expensive than others. Therefore, these families are not necessarily considered wealthier just because they attend private schools, which is their only choice.

Under the private school umbrella, there are certain schools that provide provision for children with special educational needs, such as LD, some of which follow either an Arabic, foreign language, or bilingual curriculum. Class sizes are generally smaller and teaching methods are adapted to cater to children with LD. These schools may fully cater to children with LD, which means all students attending have an LD diagnosis, while other schools provide inclusion classes. Inclusion classes are classes that include both typically developing (TD) children and LD children. Otherwise, as mentioned above, under the public-school umbrella, the LD student attends mainstream classes where extra provision is provided (Minister of Education, 2016).

1.3. The Current Study

Living in a multilingual world, the need to learn to read, write, and speak an additional language is of great importance. For example, the English language has been socially perceived as an important language and has been demanded in labour markets (United Nations Educational Scientific and Cultural Organization, 2019). This has given rise to an increase in the demand for bilingual education (Lin & Man, 2009). Although research on reading development in bilingual children has increased in recent years, there is still a dearth of evidence. In addition, a lot of research related to MA and reading has been carried out on monolingual children in English (Levesque et al., 2017; Nagy et al., 2006; Singson et al., 2000) and Arabic (Abu-Ahmed et al., 2014; Abu-Rabia, 2007; Asadi et al., 2017; Saiegh-Haddad & Taha, 2017; Tibi, 2016; Tibi & Kirby, 2017, 2018; Tibi et al., 2019). However, not a lot of research has examined MA and reading within biliterate populations learning to read in both English and Arabic at the same time. The current study aims to examine MA and reading within biliterate children in Kuwait to see whether what is known about monolinguals applies to bilinguals as well. There is growing consensus that literacy research needs to move away from a primary focus on English and other European languages (Share, 2008a), and has been including other languages to make findings related to reading development more universal (McBride et al., 2022; Verhoeven & Perfetti, 2022). Due to the prevalence of bilingual schools in Kuwait, it is important to research reading development and bilingual education to examine how skills in each language contribute to reading development and difficulties. The findings would help tailor educational recommendations more towards biliterate children with and without RD. This is the focus of this thesis.

The thesis is composed of six chapters. The next chapter reviews previous relevant literature to understand what is already known about the field and what needs to be researched further and outlines the aims and research questions of the current study. This is followed by a chapter that outlines the methods used, followed by a chapter that summarizes the results and the analyses, followed by a chapter that discusses the findings in relation to past research and theories, and finally a chapter to conclude the thesis.

2. Literature Review

2.1. Introduction

Learning oral language occurs as part of a child's natural development (Pinker, 2009). However, learning to read and write, which is an important skill for the future of every child, must be learnt through instruction. This occurs by using inventions made by humans that involve strokes on a page that represent spoken language (Stuart & Stainthorp, 2016). These strokes were invented differently in each culture resulting in different writing systems, known as the language's orthography (Henderson, 1984). For example, alphabetic languages, such as the English language, use letters to represent sounds (Stuart & Stainthorp, 2016). This chapter will outline the important skills related to reading at the word level that are universal regardless of the orthography the child is learning to read in. How these skills are used to read words in English will be outlined through different theories of English word reading highlighting that these theories do not necessarily apply to all orthographies. How different orthographies make different demands on learners will also be discussed comparing different aspects of the English and Arabic orthography, that are important to understand when conducting research related to reading in both orthographies, highlighting unique features within each. The chapter will also detail the importance of MA in reading in both the English (Levesque et al., 2021) and Arabic (Saiegh-Haddad, 2018) orthography providing the rationale behind the focus of researching MA skills, which has been largely missing in previous theories of reading in English (Rastle, 2019). Moving on, due to the prevalence of bilingualism in modern times (Lin & Man, 2009), outlining monolingual research in English and Arabic is not enough and not necessarily generalizable to the bilingual population, which provides the rationale for examining the bilingual population in Kuwait. Theories of bilingual reading are discussed shedding light on the scarcity of research related to MA skills in bilinguals and the need to explore it further. In addition, children's potential use of MA skills as a compensatory strategy while reading is considered providing another rationale behind the focus of researching MA skills. Finally, as mentioned in the previous chapter, parents experience confusion when deciding whether children with RD should or should not attend bilingual educational programs. This pinpoints a real-world problem that is explored further in the current study. The chapter outlines the relevant research related to bilingual education for children with RD funnelling down to the main aims of the current study, which are outlined at the end of the chapter.

2.2. Reading

2.2.1. Definition and types

There are many definitions of reading, but one of them is "accessing language through the eyes rather than the ears" (Stainthorp, 2020, p. 1). There are also different ways to understand reading. Reading development refers to the processes of how children learn how to read as they are developing and skilled reading refers to the skills that adults have already acquired (Stuart & Stainthorp, 2016). Before learning how to read, a child has typically already established the basic sounds in a language and knows the meaning of a lot of words (Gibson & Levin, 1975). Gough and Tunmer (1986) presented the Simple View of Reading (SVR) which simplifies the complex process of reading into the equation: R = D x C. That is, reading is the product of both decoding and linguistic comprehension. Decoding entails the processes of recognizing written words efficiently while linguistic comprehension relates to the processes of understanding words and sentences (Gough & Tunmer, 1986). Decoding includes translating the letters in words into sounds and then accessing meaning as well as being able to access the word's pronunciation without translating letters into sounds because its spelling has been stored in the mental lexicon (Hoover & Gough, 1990). This spelling pattern is argued by Hoover and Gough (1990) to be linked to its pronunciation and meaning, and as such, define the mental lexicon as a dictionary in the brain that contains information about the word's spelling, pronunciation, and meaning. The SVR has been accepted as a valid general framework (Kirby & Savage, 2008; Rose, 2006), but not a full description of reading processes. These processes will be discussed in more detail in section 2.2.2. Although the ultimate goal of reading is to comprehend the text, it is valuable to focus on word level reading as it ultimately contributes to reading comprehension in that the efficiency with which a reader can identify words and access them from memory can affect the attentional resources available for comprehension (Castles et al., 2018). This is why this thesis focuses on reading at the word level. Moreover, there are different ways in which different types of reading can be measured: measuring reading accuracy (how accurately words are read), reading fluency (how fast words are read), and reading comprehension (the extent to which the meaning of text is ultimately understood). Verhoeven and Perfetti (2022) have also defined reading development as learning how an orthography translates written symbols to spoken language, and have outlined three skills that are important when learning how to read: learning how to identify words (decoding), learning how to understand words (comprehension), and being aware of linguistic units. These linguistic units will be discussed in the next section.

2.2.2. Universal skills related to reading at the word level

Verhoeven and Perfetti (2022) analysed 17 orthographies with different writing systems including English and Arabic, and outlined universal processes that children use regardless in what orthography they are learning to read. Evidence has shown that phonological processing is important for children learning how to read in any orthography (Perfetti & Harris, 2013; Tibi & Kirby, 2019; Verhoeven & Perfetti, 2022; Wagner & Torgesen, 1987). Phonological processing is considered by Torgesen et al. (1997) to be a combination of phonological awareness (PA), phonological memory, and naming speed. The next sections will detail the aspects of phonological processing (PA and naming speed). Phonological memory relates to storing phonological information for a short period of time in short-term memory (Wagner et al., 1999), and it is important for readers to access this information from memory while decoding sounds of letters and blending them to form words (Wagner & Torgesen, 1987). Phonological memory is often measured using memory for digits and non-word repetition tasks because the phonological information of these non-words would be accessed from the short-term memory as only real words are stored in the long-term memory (Gathercole & Baddeley, 1990). Weaknesses in this skill is not thought to influence word reading if the word is already stored in the long-term memory, but it influences the attainment and reading of new words (Gathercole & Baddeley, 1990). The next sections will highlight the importance of PA and naming speed as well as the importance of letter knowledge to reading at the word level.

2.2.2.1. Orthographic unit knowledge and phonological awareness

Since this thesis focuses on alphabetic orthographies, where the orthographic units are represented by letters (Stuart & Stainthorp, 2016), then letter knowledge will be addressed in this section. Children's identification of the name and sound of a letter (grapheme) that is presented in written form is known as letter knowledge (Foulin, 2005). This type of knowledge has been shown to be associated with word reading skills (Caravolas et al., 2001) and PA (Kim et al., 2010). Before learning how to read, most children have developed some awareness of the sounds in words and are able to break them down into certain components (Smail et al., 2022). Awareness of sound structures can occur at the level of the word (e.g. cow + boy in 'cowboy'), syllable (e.g. seven has 2 syllables: sev-en), the initial phoneme in a syllable known as the onset (e.g. /s/ in sev), the remaining vowel and consonant in the syllable known as rime (e.g. 'ev' in sev), and individual phonemes (e.g. the word 'kissed' has 4 phonemes: /k/ + /i/ + /s/ + /t/) (Wagner et al., 1999). Phonemes are small units of speech sounds that change the meaning of a word (Stuart & Stainthorp, 2016). For example, when the phoneme /k/ is changed in the word 'cat' to the phoneme /b/, it changes the sound, word, and the meaning of the word to 'bat'. Phonemic awareness is a type of PA, which particularly focuses on the awareness of phonemes in words and being able to segment and blend phonemes in words (Chapman, 2003). Phonemic awareness was shown to be an important linguistic skill when learning how to read (Liberman et al., 1967; Liberman et al., 1974). Children tend to develop awareness of syllables, then onsets and rimes before developing awareness of phonemes (Treiman & Zukowski, 1996). A meta-analysis of longitudinal and experimental studies examining whether phoneme awareness or onset-rime awareness was more highly predictive of reading has shown that phoneme awareness was the strongest predictor of later reading skills in English (Melby-Lervåg, 2012). PA at the onset-rime level was shown to be important for the development of phoneme awareness (Carroll et al., 2003).

Examples of tasks that measure PA include tasks that require the child to segment or blend syllables, onsets, or phonemes. Children who score poorly on these tasks tend to be at risk of facing problems when learning how to read compared to children who score well on these tasks (Bradley & Bryant, 1978, 1983). Causal effects are usually tested in randomized experiments such as Hulme et al.'s (2012) study where the effect of an oral language skills intervention versus a phonological intervention, aimed at teaching phoneme awareness and letter-sound knowledge, was examined on children aged five years with poor verbal ability. The phonological intervention resulted in improvement in phoneme awareness and letter-sound knowledge, and additional analyses indicated that these two skills fully accounted for the improvement of word reading and spelling skills in these children 5 months later. This evidence suggests that phoneme awareness and letter-sound knowledge have a causal effect on the development of reading skills. The next section discusses the importance of naming speed and its relation to word reading.

2.2.2.2. Naming Speed

Naming speed is usually measured using a RAN task, which measures how long it takes a child to name familiar items such as objects, digits, and letters (Denckla & Rudel, 1974). Letter and digit naming has been shown to be more strongly related to reading than non-alphanumeric (objects, colours) versions of the task, though these are useful predictors of reading in pre-readers (Landerl et al., 2022). It has been shown that RAN is highly related to reading ability, especially reading fluency, in different orthographies (Caravolas et al., 2013; Georgiou et al., 2022; Tibi & Kirby, 2019). Not only does poor PA predict weaknesses in reading, but poor naming speed also does, independent of PA (Bowers & Swanson, 1991; Powell et al., 2007). Since translating letters or numbers into verbal responses in RAN tasks requires phonological skills (accessing the sounds to pronounce the words), it has been debated whether or not it's just the phonological component of the RAN task that accounts for its relationship with reading or whether the non-phonological components are related as well (Torgesen et al., 1997; Vaessen et al., 2009). Regardless of the debate, what has been agreed upon is that the process of rapid translation of letters or numbers presented as a series into verbal responses in naming speed tasks is related to the skills involved in word recognition, which also require rapid translation of letters presented in a series into verbal responses (Kirby et al., 2010). This is why RAN has been strongly associated with reading fluency. The next section discusses the importance of morphology and its association to reading beyond phonological processing skills.

2.2.2.3. Morphological awareness (MA)

Morphology is the study of how words are formed and a morpheme is the smallest unit of meaning that makes up a word (Stuart & Stainthorp, 2016). A morpheme can be a whole word or can be part of a word. For example, the word 'play' is a free morpheme as it can stand on its own. On the other hand, 'er' is a bound morpheme, which cannot stand alone but can be added e.g. to the word 'play' to produce the word 'player.' MA can be assessed using oral or written tasks. One type of task typically used to assess MA requires the child to identify whether a pair of words are morphologically related (Nagy et al., 2003). For example, the child is required to identify whether the word 'player' comes from 'play' (correct response: yes), or whether the word 'corner' comes from 'corn' (correct response: no). Another example of a task used to assess MA would be to ask the child to derive a word from a stem by completing a sentence (Carlisle, 2000). For example, presenting the word 'farm' and asking the child to complete the sentence: "my uncle is a _____" where the correct response would be 'farmer.' Another example of a task used to assess MA would be to ask the child to produce a word by making an analogy (Kirby et al., 2012). For example, the examiner would say the words 'sleep' and 'sleepy' followed by the word 'cloud' where the child is required to produce the correct response: 'cloudy.'

These different tasks assess different abilities such as the ability to judge morphological relationships, produce derived words, or decompose derived words into their root or stem, each of which differ in the extent that they require additional understanding of vocabulary and grammatical components of language (Deacon et al., 2008). This can influence the extent to which these tasks measure differences between students (Tong et al., 2011). These different types of MA tasks have been analysed in several studies which have concluded that all the tasks load onto one general factor known as MA (Goodwin et al., 2017; Kieffer & Lesaux, 2012b; Muse, 2005). Some researchers have argued that MA should be considered part of vocabulary knowledge (Spencer et al., 2015). However, evidence has shown that MA predicts word reading (Kirby et al., 2012) and reading comprehension (Deacon et al., 2017; Levesque et al., 2017) whilst controlling for vocabulary, suggesting that it should be considered as a separable influence. A study in Arabic has also shown evidence that the two can be considered separate constructs (Tibi et al., 2019).

Some tasks measure conscious activation of morphological processes (explicit), some measure implied morphological processing (implicit), and others are a combination of both (Nagy et al., 2014). Some experiments use priming, which occurs as a result of presenting a reader with a lexical decision task in which the reader must decide whether a target word exists in the language or not (Boudelaa, 2014). In a primed lexical decision task, the target word is typically presented following a prime word, which sometimes appears for such a short time it is not available to conscious processing, and these two words would either share similar morphological, orthographical, phonological, or semantic elements depending on the experiment (Boudelaa, 2014). Priming occurs when processing of the target word is affected by a related prime causing performance on the lexical decision task to be faster (or slower) than it would be if an unrelated prime was presented (Boudelaa, 2014). Researchers use these tasks to understand how words are organized in the lexicon (Boudelaa, 2014). Primed lexical decision tasks are thought to measure mostly implicit morphological processing and MA tasks such as judgement, sentence completion, and analogy mostly measure explicit morphological processes (Deacon et al., 2008). However, it is difficult to pinpoint exactly what type of processing tasks are measuring (implicit vs explicit) if not a combination of both (Nagy et al., 2014). The reason this distinction between implicit and explicit processing of morphological information is important is because of the different roles they could each play in their contribution to literacy, which will be outlined in section 2.4.5.

MA is especially important for reading because while the importance of PA and its relationship to word reading starts to decrease after the first few years of reading, the relationship between MA and reading starts to increase (Singson et al., 2000). This was shown in a study examining 9-12 year-old English-speaking children where regression analyses showed there was a strong contribution of PA to word reading in the 9 year old children, but this contribution decreased while the contribution of MA to word reading increased in the 10, 11, and 12-year-old children (Singson et al., 2000). Although this was not a longitudinal study where the same children were followed across the years to examine the PA/MA contribution changes in the same group of children, cross-sectional studies give us an idea of the relative skills used in reading across grade levels. The role of MA increases in development from around the age of 8 (Anglin et al., 1993; Berninger et al., 2010) and continues to increase up until the ninth grade (Nagy et al., 2006). When a word is identified in written form, it contains information about phonology, morphology, and meaning (Seidenberg & Gonnerman, 2000). As exposure to words increases so does awareness of morphemes, which are then used while reading in a way in which the reader decomposes words into morphemes (Ehri, 2005b). Words in a morphological family (e.g. player, playful, playfulness) share the same root morpheme (e.g. play) (Rastle, 2019). Evidence was found that when the reader is aware of the root morpheme, then this helps to identify words within the morphological family (e.g. player, playful, playfulness) (Rueckl, 2010). This is universal across multiple orthographies reviewed by Verhoeven and Perfetti (2022). However, each orthography differs in the way that phonology and morphology are represented, and in their respective roles in reading (Verhoeven & Perfetti, 2022). This will be discussed in more detail in sections 2.4.5 and 2.4.6.

To sum up, there are universal skills related to word reading across many orthographies of different types (Verhoeven & Perfetti, 2022). The relative strength of these associations, and how they might vary depending on the nature of the orthography (Caravolas et al., 2013) is tackled in section 2.3.2. Learning to read is not automatic like learning spoken language is, and it involves awareness of sounds and meaning in spoken language, learning visual symbols and sounds, storing them in memory, and accessing them rapidly. How exactly these skills are used to read words in English will be detailed in the next section.

2.2.3 Theories of English word reading

There are many different types of theories that have been put forward related to English word reading, but only the most relevant for this thesis will be covered in the next sections.

2.2.3.1. Stage theory (Frith, 1985; Seymour & MacGregor, 1984)

There is a large literature that has examined children's reading development, including developmental models of reading, in which the complex developmental process of reading is divided into stages. Stage models of reading presented by Seymour and MacGregor (1984) and Frith (1985) have argued that the reader starts out as a logographic reader, a reader that uses guessing techniques and memorizing sight words based on a salient visual feature, such as the two sticks in the word 'yellow' when they first start out learning how to read. As phonological awareness and letter knowledge develop, in the next stage, the child is able to decode graphemes into phonemes using an alphabetic strategy. Finally, the child analyses words as orthographic units without phonologically decoding each letter using an orthographic strategy. Stuart and Coltheart (1988) presented an alternative theory to previous reading development stage theories finding evidence that not all children go through the same sequence of stages when learning how to read. Some children use phonological skills and letter-sound knowledge at the initial stages of reading, and not every child starts out as a logographic reader. Stage theories are no longer prevalent as they do not capture the complex process of reading development and how the reading acquisition process varies across children or across languages. The next section details a more prevalent theory of reading development.

2.2.3.2. Phase theory (Ehri, 2005b, 2014)

A more recent and prevalent developmental model of reading, known as phase theory (Ehri, 2005b, 2014), identifies children's key reading skills in different phases and describes how these skills develop as children's reading experience increases. Children start with the pre-alphabetic phase where the reader has no knowledge of the alphabet and uses visual cues to read a word (Ehri, 2005b). When the child learns some letters and sounds, he/she uses these skills to try to read a word, usually the first and last letter of a word are identified, and the child cannot decode unfamiliar words. This is known as the partial alphabetic phase. The full alphabetic phase is reached when the child can analyse grapheme-phoneme correspondences (GPCs) accurately, can decode unfamiliar words, and can read and spell from memory. A child reaches the consolidated phase when he/she has a store of many familiar words in his/her memory with fully analysed spellings. This allows the child to decode words using larger chunks of letters (e.g. onset, rimes, syllables) as well as read and spell whole words with multiple syllables from memory. This is known as sight word reading, where spellings of words are connected to their sounds and meanings in the lexicon, which developed as a result of the accumulation of connecting letters to sounds in words (Ehri, 1995). Certain skills, such as awareness of phonemes and letter-sound knowledge, are the foundation that enable the child to move through phases (Ehri, 2017). Phase theory broadly organizes the phases according to the alphabetic skills commonly used by readers as they develop to eventually form these connections between spelling, sound, and meaning in the lexicon (Ehri, 1995, 2005b). However, as the child's reading develops, he/she may use more than one type of alphabetic knowledge from different phases to form these connections to ultimately be able to take part in sight word reading (Ehri, 2005a). Unlike stage theories of reading development where each stage contributes to the next stage, in phase theory, one phase doesn't necessarily contribute to the next (Ehri, 2020). For example, in the pre-alphabetic phase, children use visual cues to read words because they still don't know the alphabet, and this doesn't contribute to the partial alphabetic phase (Ehri, 2005b). The limitations of this theory will be discussed in section 2.4.5.

2.2.3.3. Self-teaching hypothesis (Share, 1995)

When a child learns how to connect the letters and sounds in words, then this allows the child to read words they already know from their spoken language but encounter for the first time in written form (Share, 1995). It also allows them to decode words they have never seen before if they are spelled consistently. This process is called phonological recoding. The self-teaching hypothesis (Share, 1995) suggests that with repeated opportunities to decode a word, the child will build up that word's orthographic representation and will be able to automatically identify it from the mental lexicon. The process of learning the orthographic form of the word, which allows the recognition of words automatically from the lexicon is also called orthographic learning (Castles & Nation, 2006). This process of orthographic learning enables the child to move from decoding to sight word reading, accessing the word's pronunciation directly from its spelling (Ehri, 2005a), a more efficient way to read (Share, 2008b).

A study was carried out on 8-year-old children in Israel where the first experiment presented texts containing 10 target pairs of Hebrew nonwords containing homophones where each target was shown six times (Share, 1999). Measures of orthographic learning were administered three days after every experiment in the study. These measures included an orthographic choice task with four different spellings of the target word, a naming task where a series of 60 words were presented containing the target words, and a spelling task where the spelling of the target words had to be produced. Results showed that there was quicker naming, target words were identified more successfully, and more accurate spellings of target words were produced than control words containing homophones. A second experiment using a lexical decision task that included the target words was done. This method reduced phonological recoding. This was done to ensure the student's orthographic learning was due to phonological recoding and not just being visually exposed to the words. Results showed that orthographic learning was reduced when phonological recoding was reduced. An additional experiment using the same items from experiment 2 was done by asking the students to name the words. This method involved phonological recoding again. Results showed better orthographic learning in experiment 3 than in experiment 2. The results provide evidence that phonological recoding was responsible for orthographic learning as argued by the self-teaching hypothesis (Share, 1995). These experiments have been replicated in the English orthography and evidence in support of the self-teaching hypothesis is reviewed in Castles and Nation (2006). The next section details the importance of certain linguistic components that influence representations in the mental lexicon.

2.2.3.4. Lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002)

The lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002) suggests that repeated exposure to words and phonological knowledge influences the quality of lexical representations. Lexical representations of words are stored and accessed in the mental lexicon. The hypothesis suggests that the lexical representation is high in quality if the representation is specific and redundant. The representation is specific if it contains complete and precise information about spelling, sound, and meaning. Redundant refers to whether information in any one of the three components (spelling, sound, meaning) can be predicted from the other two. A redundancy creates a strong link between a word's spelling and its pronunciation so that when a word is encountered, then its pronunciation can be immediately retrieved from its spelling and vice versa (Ehri, 2005b; Perfetti & Hart, 2002). A word is identified by retrieving these three components, and if one of the components is missing, then the lexical representation is lower in quality. High quality lexical representations are retrieved easily and consistently in a skilled reader who has more high-quality representations than a less skilled reader. Therefore, as lexical quality develops, and words are recognized automatically and efficiently, known as fluency in reading (LaBerge & Samuels, 1974), more attention can be focused on reading comprehension. Evidence has shown that measures related to word processing are correlated with reading comprehension measures (Haenggi & Perfetti, 1994; Perfetti, 1985).

A study compared the effects of teaching the meanings of uncommon words (e.g. hebetude) over four sessions to a group of readers with good comprehension skills and a group of readers with lower comprehension skills (Yang & Perfetti, 2006). After each session the participants were given a lexical decision task and they had to choose whether the word presented contained correct spelling and sounds whilst including words that contained similar orthographic and phonological aspects to the correct word. This method tested how stable the orthographic and phonological representations of the word are during learning. Results showed that the group with good comprehension skills learned the orthographic and phonological representations of the word as well as the word's meaning more effectively than the group with lower comprehension skills. This provides evidence that lexical quality reduces confusion between the spelling and sound aspect of a word and helps to form more stable representations of these aspects of a word as well as helps to retrieve the meaning of words (Perfetti, 2007). The next section details theories of adult skilled reading, which were developed separately than the above reading development theories.

2.2.3.5. The dual-route model of reading (Coltheart et al., 2001; Jackson & Coltheart, 2001)

Dual-pathway theories of reading (Coltheart et al., 2001; Jackson & Coltheart, 2001) argue that translating letters into sounds and then accessing meaning from their spoken language knowledge is important in a skilled adult, but it is not the only way to access meaning (indirect pathway). The second way to access meaning of words comes from directly accessing it through the spelling of the word, stored in the memory, without having to translate the letters into their sounds (direct pathway). In English, the letter /c/ represents the /k/ sound in the word 'cat' and represents the /s/ sound in the word 'face.' Some words contain graphemes that represent their usual and frequent phoneme following a general GPC rule, and these words are considered regular words (e.g. mint) while words that don't follow the general GPC rule are considered an exception (e.g. pint) and are classified as exception words (Stuart & Stainthorp, 2016). Consistent words are words where the rime is consistently pronounced in the same way in words that contain this rime (Stuart & Stainthorp, 2016). Dual-route theories (Coltheart, 2006) also argue that there are two routes to arrive to a meaning of a word that work at the same time (lexical and sublexical). The lexical route will produce the correct pronunciation of only the words stored in memory and access the correct meaning. Therefore, the lexical route will produce the correct pronunciation of exception words that have been stored in the lexicon and access the correct meaning. The sublexical route is argued to produce pronunciations for all words even the ones not stored in memory.

Correct pronunciations will be produced of new words and nonwords if they follow the general GPC rule or are considered consistent words. The sublexical route will produce an incorrect pronunciation of exception words and access an incorrect meaning. This is supported by neuroimaging data (images of the brain showing neural pathways) that show these two neural pathways: the dorsal pathway which is used to translate letters to sounds and then accessing meaning and the ventral pathway which is used to access meaning from spelling (Taylor et al., 2013). It has been argued that the ventral pathway develops later than the dorsal pathway (Rastle, 2019). A longitudinal study taking annual measurements of the changes in brain sensitivity as reading develops among children between the ages of 7 to 13 has shown that the brain region responsible for the ventral pathway was more sensitive to written words and this was correlated with reading fluency and not with nonword reading and phonological processing (Ben-Shachar et al., 2011). This is in line with the argument that states that as readers develop more expertise, they rely less on the dorsal pathway and more on the ventral pathway (Pugh et al., 2000). The theories of adult skilled reading have been criticized in the literature because they focus on adult skilled reading only and don't take into consideration development of skills, such as PA, that takes place before children start to learn how to read (Ziegler & Goswami, 2005). Another criticism is that the dual-route theory (Coltheart et al., 2001; Jackson & Coltheart, 2001) is not generalizable to other orthographies that don't contain exception words (Shany et al., 2023; Share, 2008b).

Most of the reading theories discussed above have been based on English and alphabetic orthographies. Although some of the processes are universal and can be applied to any orthography, especially phonological processing, other processes may be more important in other orthographies or have different degrees of importance (Landerl et al., 2018). One important aspect that is missing in these theories is the role morphology plays in word reading (Levesque et al., 2021; Rastle, 2019). In addition, the recent approach in the literature has been highlighting the need to include other orthographies to understand reading development from a universal lens rather than from an "Anglocentric" lens (McBride et al., 2022; Share, 2008b; Verhoeven & Perfetti, 2022). The next section details different types of orthographies focusing on the English and Arabic orthography, the differences between them, and their unique features that influence word reading.

2.3. Orthography

2.3.1. Orthography types

As mentioned earlier in the introduction, each orthography contains strokes that were invented by humans to represent spoken language (Stuart & Stainthorp, 2016). These strokes, also known as graphic units, may represent different sizes of linguistic units (word, syllable, phoneme) in different orthographies (Gelb, 1963). For example, in logographic orthographies like Chinese, the graphic units represent a whole word (the largest linguistic unit). Also, in syllabaries like Japanese Kana, the graphic units represent syllables. Finally, graphic units that represent phonemes (the smallest linguistic unit) are known as alphabetic orthographies where letters known as graphemes are used to represent phonemes (Stuart & Stainthorp, 2016). These graphemes represent sounds of speech, known as phonology, which are blended to translate into words and meanings. Different alphabets are used to represent phonemes (Stuart & Stainthorp, 2016). Long ago, the Phoenicians used an alphabet that contained letters that represent consonant phonemes only. Alphabets were later developed by the Greeks to contain letters that represent vowel phonemes as well (Stuart & Stainthorp, 2016). Writing systems with mostly letters that represent consonant phonemes are still prevalent today and found in Arabic and Hebrew orthographies (Stuart & Stainthorp, 2016). The Arabic alphabet is considered an abjad, which is a writing system where the symbols represent consonant phonemes mostly and the letters representing vowel phonemes are represented in a minor manner (Daniels, 1992; Russak, 2021). Arabic and English are alphabetic orthographies where the Latin alphabet represents the phoneme (the smallest linguistic unit) in the English orthography while the abjad alphabet represents the phoneme in the Arabic orthography, as seen below in Figure 1. A comparison of the two orthographies is discussed in Section 2.3.5.

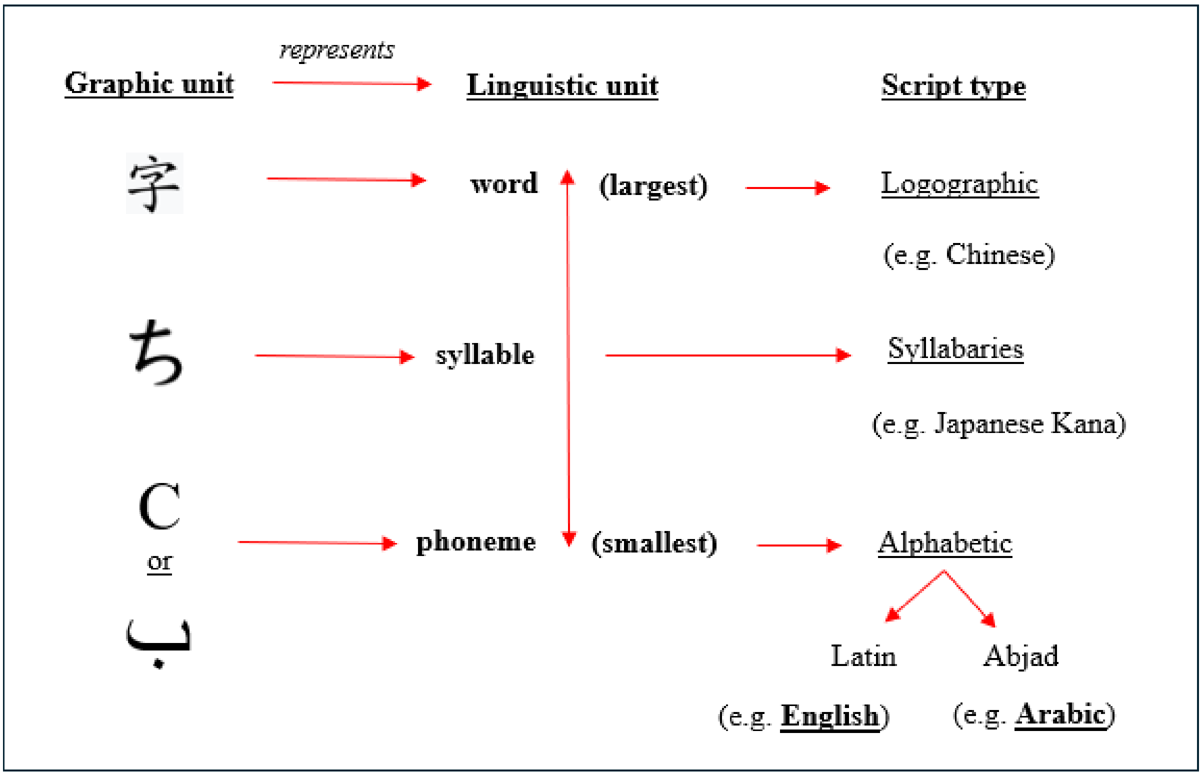

Figure 1. Arabic and English orthographies within the population of orthographies

2.3.2. The demands orthographies make on learners

Written words represent spoken language, and different writing systems map linguistic units (phoneme, syllable, morpheme) differently (Verhoeven & Perfetti, 2022). Writing systems differ in the extent that sounds can be predicted from the graphic units presented visually (Stuart & Stainthorp, 2016). For example, Chinese scripts (where symbols represent a whole word) require children to memorize thousands of graphic units. Therefore, it takes a long time to be a fluent reader of Chinese scripts. On the other hand, alphabetic orthographies have fewer graphic units that need to be memorized, but some of these alphabets do not represent sounds in a predictable way.

If an alphabetic orthography contains, for example, 25 letters and 25 phonemes, and each letter corresponds to one phoneme in a consistent manner, then this orthography is considered predictable and regular, such as Turkish (Stuart & Stainthorp, 2016). For example, the letter <ş> is always pronounced with the /sh/ sound. There is no confusion about GPCs in this orthography, it contains transparent words, and is also considered a shallow orthography as its GPCs are constant (Katz & Frost, 1992). Alphabetic orthographies are usually categorized based on how transparent their GPCs are, and this spectrum of consistency is referred to as their orthographic depth (Liberman et al., 1980). If some graphemes can translate into more than one phoneme and if one phoneme translates into more than one grapheme, then the GPCs in this writing system are inconsistent and the orthography is considered unpredictable, such as English. As mentioned in section 2.2.3.5, English contains regular and exception words. In addition to that, some words (e.g. calm) contain consonant letters that are not sounded out, these words are considered opaque as the graphemes do not represent phonemes in a transparent way (Stuart & Stainthorp, 2016). Also, sometimes two letters must be decoded together, known as digraphs, to represent a single phoneme (example: ee in ‘seed’). At other times three or more letters which include consonants all represent one vowel phoneme (example: eigh in the word ‘eight). This may be confusing for beginner readers and children must learn that these graphemes represent one single phoneme and be able to recognize these patterns in the orthography (Stuart & Stainthorp, 2016). The English orthography is considered a deep orthography as its GPCs are not consistent but it follows a consistent morphological structure (Katz & Frost, 1992). In any alphabetic language, single words have two structures (phonemic and morphemic), and the extent to which the orthography preserves either structure varies in each language (Perfetti & Harris, 2013). Some English words have inconsistent GPCs because the spelling of these words preserves the morphemic structure (Chomsky, 1970). For example, the words: ‘snored’ and ‘kicked’ are both spelled with the suffix ‘ed’ at the end of the word to indicate that the verbs are in past tense (Levesque et al., 2021; Rastle, 2019). However, they are both pronounced using different phonemes: /d/ for snored and /t/ for kicked. The definition of orthographic depth that focuses solely on whether GPCs are transparent or not has been criticized in recent literature (Daniels & Share, 2018; McBride et al., 2022), and it has been argued that other elements from different orthographies should be added to make the orthographic depth definition more universal. This will be discussed further in sections 2.3.5 and 2.3.6.

The ease with which a child learns to decode written words depends on the writing system the child is learning to read. As mentioned in section 2.2.2.2, before learning how to read children develop phonological representations from their spoken language (Goswami, 2010). However, it has been argued that phonemic awareness develops differently when learning to read in different languages (Ziegler & Goswami, 2005). That is because some languages contain letters with consistent GPCs and some languages have more complex syllable structures both of which influence the development of phonemic awareness and reading ability in the first few years of reading acquisition (Goswami, 2010; Seymour et al., 2003). It is argued that readers of orthographies with varying level of consistency may use different strategies to access words from their lexicon (Carello et al., 1992). According to psycholinguistic grain size theory (Ziegler & Goswami, 2005), in consistent orthographies, readers may easily rely on small grain sizes (phonemes) while reading as letters represent sounds in a predictable manner. However, in inconsistent orthographies where GPCs are unpredictable, readers need to flexibly use both small (phonemes) and large grain sizes (onsets, rimes, syllables) while reading. The process used in reading consistent orthographies (phonemic strategies) is less demanding than the process children use while reading in inconsistent orthographies. That is because they need to rely on multiple strategies to read: a combination of phonemic strategies as well as identifying larger grain sizes (which also may include inconsistent GPCs). This is why readers might take longer to learn how to read in an inconsistent orthography than a consistent one. For example, Turkish and Italian words are learned faster than Arabic words (Verhoeven & Perfetti, 2022). English words were found to be the hardest to learn, and children need around 4 years to be able to accurately read words in English, unlike in more consistent European orthographies where children were competent readers after a single year (Seymour et al., 2003). However, although it might take longer to learn how to read in different orthographies, the universal skills related to reading are similar (Caravolas et al., 2013; Seymour et al., 2003). They are just weighted differently depending on the orthography (Saiegh-Haddad & Geva, 2008).

The extent to which PA predicts reading development in a consistent orthography is argued to be lower than it is in English, an inconsistent orthography (Georgiou et al., 2008; Liberman et al., 1980; Ziegler & Goswami, 2005). The relationship between PA and reading in English has been shown empirically to last longer across the early stages of reading than in consistent European orthographies (Caravolas et al., 2013). A strong relationship between PA at the onset-rime level and early reading ability was argued to exist in inconsistent orthographies since these orthographies present the onset and rime more transparently than the phoneme (Goswami, 1999, 2002). It has also been argued that RAN is more relevant in consistent orthographies because reading accuracy reaches ceiling levels earlier than inconsistent orthographies; therefore, reading fluency is used as a measure of differentiation between children rather than reading accuracy (Georgiou et al., 2008; Kirby et al., 2010; Landerl & Wimmer, 2008). However, studies have shown that RAN is more strongly associated with reading in inconsistent orthographies like English than consistent orthographies like Finnish or Greek (Araújo et al., 2015; Moll et al., 2014). It is therefore still unclear whether RAN is more relevant to reading in consistent/inconsistent orthographies, but what is clear is that RAN is associated with reading development in all orthographies including consistent/inconsistent alphabetic orthographies as well as non-alphabetic orthographies like Chinese (Landerl et al., 2022). The psycholinguistic grain size theory (Ziegler & Goswami, 2005) only focuses on the consistency of phonological units represented by orthographies. However, in the English and Arabic orthography, morphological units are also represented by the orthography and are considered important (Share, 1999). The next sections discuss the English and Arabic orthography, the differences between them, the unique aspects of the Arabic orthography, and finally the importance of morphology in each of the orthographies.

2.3.3. English Orthography

The Latin alphabet is used in the English language to translate graphemes into phonemes (Stuart & Stainthorp, 2016). There are 24 consonant phonemes and 20 vowel phonemes in English (Stuart & Stainthorp, 2016). However, there are only 26 letters to translate into 44 phonemes. Of these 26 letters, five are vowel letters (a, e, i, o, u) while the rest are consonant letters except for the letter y that sometimes also represents a vowel phoneme. Vowel phonemes and consonant phonemes can be represented by more than one letter (e.g ow or sh) (Geva & Siegel, 2000). As mentioned in section 2.3.2, the English orthography is considered deep, phonologically complex, contains many syllables, and preserves the morphemic structure (Katz & Frost, 1992; Perfetti & Harris, 2013). The next section will detail the unique aspects of the Arabic orthography.

2.3.4. Arabic Orthography

Arabic is a South-Central Semitic language, and Semitic languages share aspects of their phonological and morphological structure (Holes, 1995). Semitic languages include Arabic, Hebrew, Amharic, Maltese, and Aramaic dialects spoken in Syria and Iraq (Haywood & Nahmad, 1965). The Arabic orthography consists of 28 letters that represent consonants (Saiegh-Haddad, 2017). Of the 28 letters, three letters (أ / و / ي) represent both consonant and vowel sounds, known as long vowels. Written words in Arabic always involve a combination of consonants and sometimes long vowels grouped into simple syllables, written in cursive format, and are read from right to left (Saiegh-Haddad, 2017). Although words are written through ligaturing (cursive format), there are six letters that do not connect to other letters (Mahfoudhi et al., 2011). This creates gaps in words as seen in the last word in Figure 2 below. Beginner readers are taught to read in voweled Arabic, which is text that contains added diacritics. Diacritics represent short vowels which are placed above or below the consonants such as ◌َ/a/, ◌ُ/u/, and ◌ِ/e/. Other diacritics such as ◌ّ may be used to indicate whether a consonant should be pronounced for a longer period (consonantal gemination) as well as ◌ْ to indicate the absence of a vowel (null vocalization) (Saiegh-Haddad, 2018).

These diacritics are known as phonemic diacritics as they provide phonemic information. There is another set of diacritics that serve grammatical purposes which are placed at the end of the word (Saiegh-Haddad, 2018). It is important to note that phonemic diacritics provide phonological information that may change the meaning of the word like in the earlier example of when the phoneme /k/ is changed in the word ‘cat’ to the phoneme /b/, it changes the sound and the meaning of the word. However, grammatical diacritics are usually used to serve grammatical purposes, which do not influence the meaning of the word but add additional sounds. Phonemic diacritics are used for beginner readers, the Holy Quran, and children’s literature (Saiegh-Haddad, 2017). Unvoweled text does not contain diacritics and is used in most Arabic script. It is important to note that unvoweled text is missing short vowels only, due to the absence of diacritics, but still contains the three letters that represent long vowels (marked in red) as seen in Figure 2.

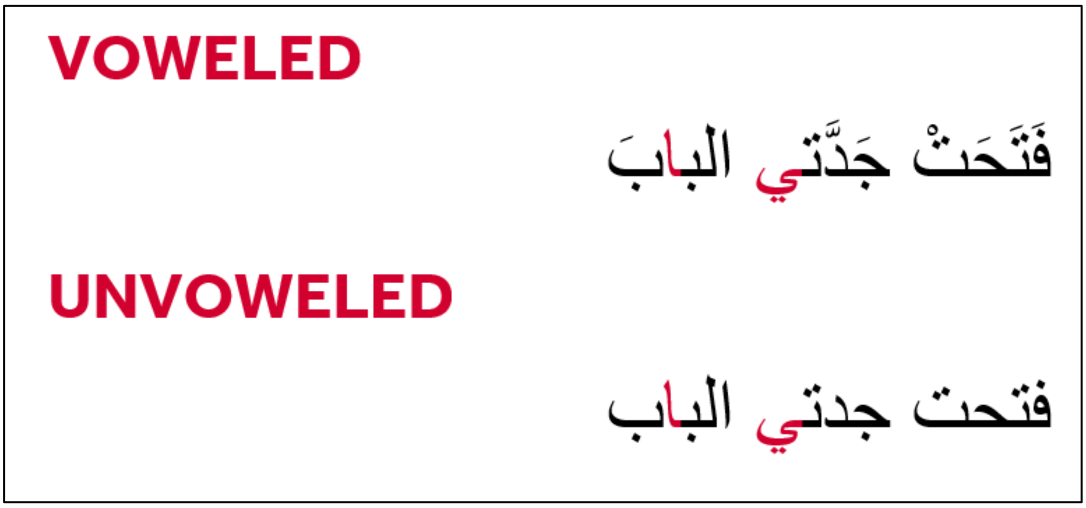

Figure 2. Arabic Voweled and Unvoweled Script (long vowels marked in red)

The Arabic orthography is considered consistent when it is voweled with almost all of the phonological information represented in a transparent manner (Saiegh-Haddad, 2017). Due to the missing short vowels in unvoweled script, the relationship between letters and sounds is less transparent. Some words can look identical in unvoweled script (mostly three consonant letter words), but have different pronunciations and meanings resulting in homographs (Holes, 1995). When encountering a homograph, the reader must use context to obtain the correct phonological form of the word (Mahfoudhi et al., 2010). Letters, in the Arabic orthography, are very similar visually and differences between letters can be a small dot (Asaad & Eviatar, 2013; Ibrahim et al., 2002). To add to the complexity of the orthography, letters also have different forms depending on their position in the word (Elbeheri et al., 2006).

Arabic has two oral forms: standard and colloquial (Saiegh-Haddad, 2017). Colloquial refers to the range of dialects spoken, and standard Arabic is used for literacy. There is no formal written form of colloquial Arabic. The dialects in spoken Arabic are different depending on the region someone is from. This dialect is acquired at home while standard Arabic is usually acquired at school for literacy purposes (Omar, 1973). Standard Arabic is expected to be spoken in Arabic language classes as well as in formal and educational settings (Badawi, 1973). All children are exposed to colloquial Arabic at home with minor exposure to spoken standard Arabic. When children start school, they are more formally exposed to spoken standard Arabic, and when children start to read, they will learn to read in standard Arabic. The existence of different forms of a language is an example of diglossia, which is when two types of a language are used within the same community (Ferguson, 1959). The spoken Arabic form is less morphologically and grammatically complex than the standard form, and the two versions differ in phonology (e.g. different pronunciations, different phonemes), syllable structure, stress patterns, and vocabulary (Eid, 1990; Ibrahim, 1983). For example, the word 'window' in Standard Arabic (نافذة) is a completely different word in Kuwaiti Arabic (دريشه). Also, when pronouncing the word 'dog' in Standard Arabic (كلب), the word is pronounced with the /k/ phoneme to pronounce /kalb/ while in Kuwaiti Arabic the word is pronounced with the /ch/ phoneme to pronounce the word /chalb/. The /ch/ phoneme exists in Kuwaiti Arabic but does not exist in Standard Arabic and does not exist in some other colloquial dialects. A study examining 5-year old children who speak Palestinian Arabic showed that 40% of the words in the child's lexicon have no standard Arabic equivalent, 40% of the words are almost identical to standard Arabic (cognates), and 20% of the words are identical (Saiegh-Haddad & Spolsky, 2014). The percentage may vary depending on the dialect analysed, and there are no studies that have analysed these percentages in children who speak Kuwaiti Arabic. A study has analysed several dialects (Algerian, Tunisian, Palestinian, Syrian, Egyptian, Jordanian, Lebanese), and found that Palestinian Arabic is the closest to Standard Arabic (Abu Kwaik et al., 2018).

2.3.5. Comparison between English and Arabic Orthography

This section will compare the English and Arabic orthographies. The English and Arabic orthographies' graphic units both represent the smallest linguistic unit, the phoneme. However, English uses the Latin alphabet to represent its phonemes while Arabic uses abjad letters to represent its mostly consonant phonemes (Stuart & Stainthorp, 2016). It has been established, in section 2.3.2, that the English orthography is considered deep because of its inconsistent GPCs (Stuart & Stainthorp, 2016). It has also been established in section 2.3.4 that the Arabic orthography is considered shallow when it is voweled and deep when it is unvoweled (Saiegh-Haddad, 2017). The definition of a deep orthography is that it contains inconsistent GPCs (Katz & Frost, 1992), as mentioned in section 2.3.2. However, the unvoweled Arabic orthography does not contain inconsistent GPCs like the English orthography does, but it is the missing vowels that make the unvoweled Arabic orthography to be considered deep (Verhoeven & Perfetti, 2017). This is an additional element that has been added to the definition of orthographic depth that does not focus solely on GPCs but includes other elements from other orthographies to make the orthographic depth definition more universal (Daniels & Share, 2018), as mentioned in section 2.3.2.

The visual complexity of letters in an orthography is not often discussed because alphabetic orthographies with Latin-based letters are usually considered relatively uncomplex (Verhoeven & Perfetti, 2022). Verhoeven & Perfetti (2022) ranked the scores of 17 orthographies based on the visual complexity of the letters in the orthography. This score, called GraphCom (graph complexity) was created by Chang et al. (2017) who have analysed over 100 languages and their letters from five different writing systems. The score takes into account important elements of graphs: perimetric complexity, number of simple features, number of connected points, number of disconnected points. Perimetric complexity refers to the ratio of the background space of the letter relative to how dense the lines of the letter are (Pelli et al., 2006). Results showed that the highest GraphCom was evident in the Chinese orthography with a rank of 1, Arabic scored a rank of 8 in terms of graph complexity, and English scored a rank of 15.5 (Verhoeven & Perfetti, 2022). The orthography with the lowest rank (18) of graph complexity score was Hebrew. Therefore, the difference in graph complexity between the English and Arabic orthography is evident (Verhoeven & Perfetti, 2022). How these differences between the English and Arabic orthography with its unique features influence reading skills and word reading will be detailed in the next section.

2.3.6 Unique features of Arabic Orthography that influence word reading

As mentioned in section 2.3.4, the missing vowels in the Arabic unvoweled orthography makes reading more difficult (Frost et al., 1987), and is a component of its orthographic depth (Daniels & Share, 2018). In addition to that, diglossia is a unique feature of the Arabic orthography, and has been argued to be an additional component to its orthographic depth (Daniels & Share, 2018). Researchers have examined whether diglossia influences the development of linguistic skills related to reading and word reading skills. Results have shown that when 6-7 year old Arabic-speaking children in Israel who speak Palestinian Arabic were examined and were given phoneme manipulation tasks, children found it more difficult to manipulate phonemes that are available in standard Arabic and not spoken Arabic (diglossic phonemes) while performance on tasks that did not contain diglossic phonemes did not influence phonemic awareness (Saiegh-Haddad, 2003, 2004). Therefore, since some sounds acquired in standard Arabic do not match the sounds children have acquired as part of their spoken language, then this creates a linguistic distance between spoken and written language and influences the development of PA (Saiegh-Haddad, 2003, 2004, 2005). Although the version of spoken Arabic is only oral and not written, Saiegh-Haddad and Schiff (2016) created a set of written words to represent spoken Arabic words, and found that 7, 9, 11, 13, and 15-year-old Arabic-speaking children in Israel scored lower on voweled and unvoweled reading accuracy and fluency in standard Arabic compared to spoken Arabic suggesting that diglossia influences reading accuracy and reading fluency.

As mentioned in section 2.3.2, the extent to which PA predicts reading development in a consistent European orthography is argued to be lower than it is in an inconsistent orthography like English (Georgiou et al., 2008; Liberman et al., 1980; Ziegler & Goswami, 2005). However, PA is a strong predictor of reading in voweled Arabic despite having a consistent relationship between spelling and sounds (Abu-Ahmed et al., 2014; Mannai & Everatt, 2005; Smythe et al., 2008; Taibah & Haynes, 2011; Tibi & Kirby, 2018). Although development of word reading accuracy and speed in consistent orthographies should be easier and faster (Seymour et al., 2003), reading accuracy rates of voweled Arabic word reading (67%) and non-word reading (63%) in second graders has been reported to be low (Abu-Ahmed et al., 2014), and non-word reading speed to be extremely low for a consistent orthography (Saiegh-Haddad, 2005). Reading accuracy rates for a consistent orthography, like Italian, have been reported to be 94% for word reading 82% for non-word reading in second graders (Cossu et al., 1988). The reason reading accuracy rates are lower for voweled

Arabic despite it having transparent GPCs has been argued to relate to diglossia (Schiff & Saiegh-Haddad, 2017). When the child translates these letters to sounds in voweled Arabic consistently, these phonemes do not match the phonological representations stored in the child's lexicon (Saiegh-Haddad & Spolsky, 2014). This is why it has been questioned whether voweled Arabic should be considered a shallow orthography or not adding diglossia as yet another dimension to the definition of orthographic depth (Daniels & Share, 2018), as mentioned in sections 2.3.2 and 2.3.5.

Another source of complexity arises from several unique factors relating to the nature of Arabic letters, see section 2.3.4. A study examining 15-year-old Arabic-speaking students in Israel were asked to perform a trail making test, which requires connecting numbers and letters (Ibrahim et al., 2002). The students performed slower on the version with the Arabic letters than the Hebrew letters, although Hebrew is their second language, suggesting that visual complexity of Arabic letters could be the reason (Ibrahim et al., 2002). Another study examining 7-, 9-, and 11-year-old Arabic-speaking children in Israel also found that children performed slower in letter naming tasks for the letters in Arabic that look the same and are distinguished by small dots (Asaad & Eviatar, 2013). These letters have also resulted in slower word reading for 8-9 year old Arabic-speaking children in Israel (Dai et al., 2013). However, contrasting results were shown in a study examining letter knowledge in 5-year-old Arabic-speaking children in Israel where visual similarity of letters was not associated with letter knowledge (Tibi et al., 2022). The difference in the results of Tibi et al.'s (2022) study and Asaad and Eviatar's (2013) study was due to different tasks and methods used. Another study examined 7-, 9-, and 11-year-old Arabic-speaking children in Israel as well as university students found that children performed slower in letter naming tasks for letters that represent diglossic phonemes than letters that do not while this effect was not found in university students (Asaad & Eviatar, 2013). Diglossia also negatively influenced letter knowledge among the children examined in Tibi et al.'s (2022) study, mentioned above. There has been contradicting evidence whether or not ligaturing influences reading in Arabic in a positive or negative way (Dai et al., 2013; Taha & Khateeb, 2018; Tibi et al., 2020). However, as mentioned in section 2.3.4, some letters in Arabic are not joined by ligaturing, called radical letters, which might cause confusion for readers as it creates spaces within words and might create unclear word boundaries (McBride et al., 2022).

To sum up, visual complexity of letters influences a child's ability to learn to read: the more complex the letters are, the more difficult the reading acquisition process is (Verhoeven

& Perfetti, 2022). Therefore, the complexity of the letters in the Arabic orthography is evident and imposes a challenge when learning to read in Arabic (Verhoeven & Perfetti, 2022). Verhoeven and Perfetti (2022) argue that the reason graph complexity influences reading is because it influences the ability to learn orthographic representations, which in turn influences lexical quality, mentioned above, in the lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002). Daniels and Share (2018) argue that earlier conclusions and hypotheses that were developed based on research examining English and European alphabetic orthographies focusing on the concept of spelling-sound consistency only do not apply to an orthography like Arabic. That is because the additional unique dimensions of the orthography (missing vowels, visual similarity of letters, ligaturing, different forms of letters depending on position in word, letters that represent both consonants and vowels, diglossia) that may influence reading development are not considered (Daniels & Share, 2018). All these additional dimensions add to the complexity of the orthography and its orthographic depth. Another unique aspect of the Arabic orthography is how it represents its morphological structure, a concept in linguistics that is important to understand when studying reading (Gibson & Levin, 1975), which will be discussed in the next section.

2.4. Morphology

2.4.1. Morphology types

Morphology is divided into two types: inflectional and derivational (Carlisle, 1995). Inflectional morphology is related to adding morphemes to a word to change its meaning without changing its grammatical category (Nunes & Bryant, 2011). For example, adding ‘s’ to the word ‘tray’ results in ‘trays’, which adds a plural meaning, but the word is still a noun. Derivational morphology involves adding morphemes that change both the meaning and the grammatical category usually resulting in the production of a new word that shares the original meaning of a root word (Nunes & Bryant, 2011). For example, adding ‘er’ to the word ‘play’ results in ‘player’ changing the meaning of the word as well as its grammatical category from a verb to an agentive.

2.4.2. English morphology

In English, to derive a new word, an affix such as a prefix or suffix is added to a free stem, which is an independent word that is considered a morpheme. For example, using the free stem ‘employ,’ (an independent word that is considered a morpheme), a new word ‘unemployment’ is derived by adding affixes in a linear manner (un as a prefix and ment as a suffix). The same process is followed to inflect a word as well where grammatical components are added to the end of the word (example: tray/trays). When a word consists of one morpheme it is considered morphologically simple (e.g. view), but when it consists of more than one morpheme it is considered morphologically complex (e.g. viewer) (Diependaele et al., 2012). As mentioned in section 2.3.2, the English orthography preserves its morphemic structure (Perfetti & Harris, 2013), and certain morphemes can be pronounced with different phonemes (e.g. kicked and snored where ed is pronounced with the phoneme /t/ in the former word and /d/ in the latter word). Since the same morpheme can be translated to different phonemes, then this is called a morphophoneme (Perfetti & Harris, 2013). English is known to be morphophonemic, and it has been argued that although spelling to sound relationships are inconsistent in English, morphemes create consistent spelling to meaning relationships creating "islands of regularity" (Rastle et al., 2000, p. 527). That is because words with the same stems or root morphemes (also called a morphological family) share similar meanings (e.g. sign, signature), and some suffixes (e.g. 'er') also share meanings (Plaut & Gonnerman, 2000; Rastle & Davis, 2008). For example, the suffix 'er' in the words: 'player', 'teacher', 'cleaner' indicates the meaning that a person is doing the action. Eighty percent of words in English contain several morphemes and are therefore considered morphologically complex (Hiebert et al., 2018). The next section will detail the unique morphological structure of the Arabic orthography, which it shares with other semitic languages such as Hebrew (Holes, 1995).

2.4.3. Arabic morphology

According to the morpheme-based theory (Cantineau, 1950; McCarthy, 1981), most words in Arabic are derived in a non-linear manner (unlike English where words are derived in a linear manner by adding affixes). The theory suggests that most words, including verbs and nouns, are derived by combining two morphemes: the root and the word-pattern. The root and word-pattern are abstract concepts, and in order to create real words, they are combined together using phonetic rules to create real word stems (Saiegh-Haddad & Henkin-Roitfarb, 2014). The root is usually made up of three or four consonants. For example, ('ك ت ب') is a root shared by all words related to 'write' (Saiegh-Haddad & Henkin-Roitfarb, 2014). The order of the letters in the root is very important (Velan & Frost, 2011): once the order is changed, then the meaning would change. It is important to note that the root is not a word (like 'write' is in English), it is an abstract morpheme that does not stand on its own as an independent word and is not pronounceable (Shimron, 2003). The word-pattern is a template (e.g. agentive Ca:CeC) that is used to combine root consonants with long or short vowels to derive a real word stem. In this example, (agentive Ca:CeC), C indicates the slot into which the root consonant is to be inserted and ‘a’ and ‘e’ represent the short and long vowels (Saiegh-Haddad & Henkin-Roitfarb, 2014). The result is the derived real word stem (كاتِب) which means ‘writer,’ as seen in Figure 3. The Arabic orthography’s written unit represents the phoneme but the consonant root morphemes are transparent in the orthography connecting different words with the same consonant root: (‘ك ت ب’) to all words related to ‘write’ (Frost, 2012).

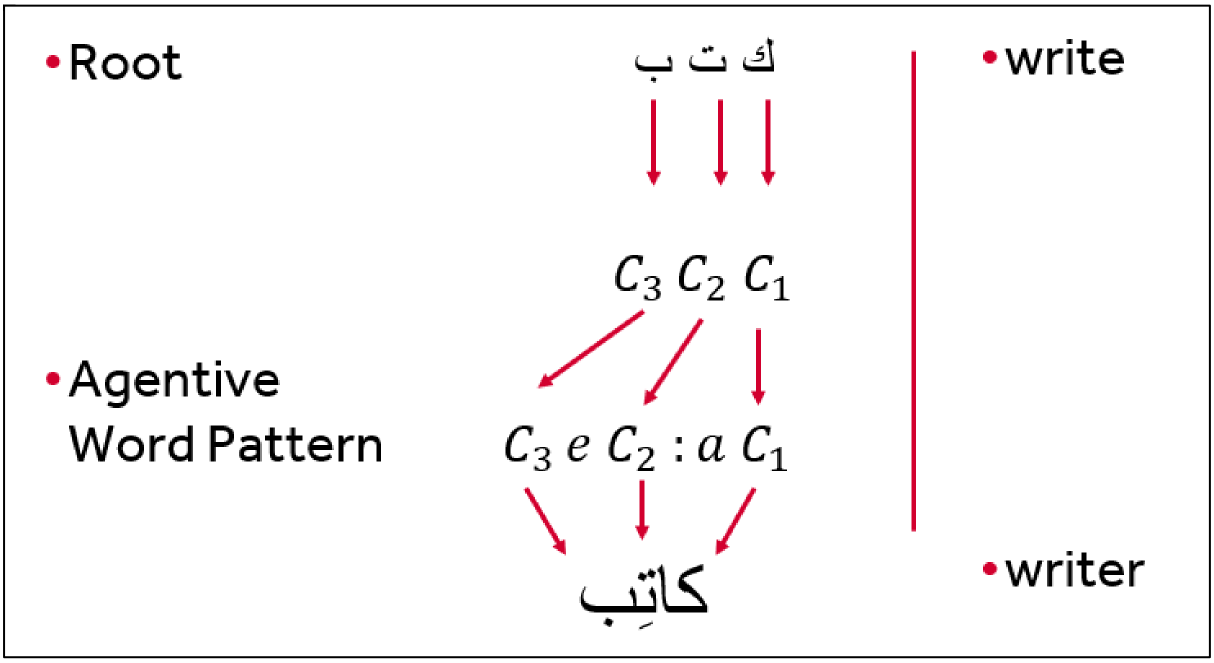

Figure 3. Deriving a word in Arabic

Most agentive words follow the same structure presented in the word-pattern above (agentive Ca:CeC). An additional example would be to take the root consonants (ل ع ب) a root shared by all words related to ‘play,’ and map them onto the word-pattern structure above resulting in the derived word (لاعِب) which means ‘player.’ Since agentive words in Arabic follow the same word-pattern, then words that follow the same word pattern fall under the same categorical meaning: the person doing the action (e.g. writer, player, etc.). Therefore, the word-pattern provides a word’s categorical meaning and phonological form. There are two types of word-patterns: verbal and nominal (Abu-Rabia, 2007). When verbal patterns are combined with a root, a verb is derived while nouns and adjectives are derived when combining nominal patterns and roots. There are 10 frequent verb patterns whereas nominal word patterns are a much larger set (Holes, 2004). A small proportion of words do not follow this systematic root and word-pattern morphemic structure; therefore, the pronunciation and the meaning of the word cannot be recovered from its morphemic structure (Saiegh-Haddad & Henkin-Roitfarb, 2014).

In inflectional morphology, words are inflected using prefixes and suffixes added to the derived real word stem in a linear manner (Abu-Rabia, 2007). Inflecting verbs in the past, present, and future tenses take into consideration person, number, gender, and mood by adding prefixes and suffixes to the verb. Nouns are inflected by considering gender and number with different forms for, masculine singular, feminine singular, masculine pairs, feminine pairs, masculine plural, and feminine plural (Abu-Rabia, 2007). Inflection can also be represented by short vowels or nunation represented by diacritics at the end of a word (Mahfoudhi et al., 2010). Nunation is the use of double diacritics in writing at the end of a noun to indicate the pronunciation of the phoneme /n/ at the end of the word and serves as an indication of the grammatical function of the word as well as to indicate case: nominal, accusative, and genitive. Also, object pronouns, the definitive article, prepositions and conjunctions can be attached to the word as well, known as clitics, serving a grammatical purpose (Mahfoudhi et al., 2010).

2.4.4. Comparison between English and Arabic morphology

Key research in the field of Arabic morphology, which draws out the way in which it differs from English morphology, has been carried out by Tibi, Kirby and colleagues (Tibi et al., 2020; Tibi & Kirby, 2017, 2019; Tibi et al., 2019). As mentioned in Section 2.4.3., most words in Arabic are made up of two morphemes (the root and the word-pattern) and derived in a non-linear manner (Saiegh-Haddad & Henkin-Roitfarb, 2014). In addition, Arabic morphology is known to be root-based, where the root is an abstract morphemic unit and not a real word (Cantineau, 1950; McCarthy, 1981). The root is also considered to be noticeable in most Arabic words and plays an important role in the recognition of words (Boudelaa & Marslen-Wilson, 2001). In English orthography, on the other hand, the morphology is known to be stem-based where words are derived in a linear manner by adding prefixes and suffixes to the stem, which in English is both a real word and a morpheme (Carlisle, 1995). Tibi et al. (2019) have highlighted that the root or stem in English is different than the root in Arabic as the root in Arabic is made up of consonants only. It is thus not a pronounceable word but rather an abstract morpheme that is connected to a word-pattern. Tibi and Kirby (2019) also argue that since the consonant letters of the Arabic root are broken up while deriving a word in a non-linear manner, then this may make the orthographic representation of the root harder to learn in Arabic than in English where the root morpheme is represented in a linear manner

(Tibi & Kirby, 2019). Therefore, Tibi et al. (2019) argued that the type of tasks used to measure morphology in English may not be adequate to measure the nonlinear dimension of Arabic morphology. This was their rationale for developing a task in Arabic that measures root awareness, a feature in Arabic that is not found in English. Results showed that the task predicted several reading outcomes among 8-year-old Arabic-speaking students in the UAE (Tibi et al., 2019).

Tibi and Kirby (2017) have also highlighted that Arabic morphology is a dense morphology because it includes both linear and non-linear dimensions (Boudelaa, 2014), another aspect of Arabic morphology that distinguishes it from English morphology. Unlike derivational morphology, Arabic words are inflected in a linear manner (Abu-Rabia, 2007). Tibi and Kirby (2017) also highlight another dimension of Arabic morphology, which is that the oral spoken dialect is different from the written Standard Arabic form (Tibi & Kirby, 2017). However, their study examining the multidimensionality of 10 different Arabic MA tasks using factor analysis among 8-year-old Arabic-speaking students in the UAE showed that the measures all load onto one factor (Tibi & Kirby, 2017). This suggests that despite the complexity of Arabic morphology and different dimensions to it, MA in Arabic is unidimensional. On the other hand, when a different model was used in the analysis, results showed a differentiation between the oral factor and written factor (Tibi & Kirby, 2017). Although the English language does not contain an oral form that is different to the written form nor does it include linear and non-linear dimensions, it is considered multidimensional (Goodwin et al., 2017; Levesque et al., 2021), and this will be elaborated further in the next section.

Finally, another aspect of Arabic morphology that distinguishes it from English morphology is that English words may contain one morpheme whereas Arabic words mostly contain two morphemes (for the exception of some words such as the pronoun ‘he’ and the preposition ‘in’ (Tibi et al., 2020)). Tibi et al. (2020) highlight the importance of the number of morphemes in Arabic words by examining several word-level factors (e.g. number of letters, syllables, morphemes, ligaturing, frequency of root) that would influence Arabic word reading among 8-year-old children in the UAE. Results showed that the number of morphemes only at the word-level and a child’s morphological awareness at the personal-level significantly predicted Arabic word reading (Tibi et al., 2020). This highlights the complexity of Arabic words and the importance of its morphology. Therefore, the difference between the two orthographies and the way morphology is marked is evident, which may influence the different role morphology plays in word reading in the different orthographies (Boudelaa, 2014), which will be discussed in the next two sections.

If the sound and the meaning of a complex word can be retrieved from its morphological structure, then this word is thought to be morphologically transparent (Elbro & Arnbak, 1996). In English, when deriving a word, the word stem's phonological or orthographic structure may change (Saiegh-Haddad & Geva, 2008). For example, nation-national (phonological shift), easy-easily (orthographic shift), decide-decision (phonological and orthographic shift). When word stems go through these shifts, then the morphological structure becomes less transparent. However, in general, English is thought to be morphologically transparent. In Arabic, since the derivational process is non-linear and the root consonants are inserted within fixed slots in the word-pattern, then the phonological and orthographic structure of the root is changed and broken up making it more complex (Saiegh-Haddad & Geva, 2008). However, although the root is broken up when deriving a word in Arabic and is morphologically complex, the consistent use of familiar roots to derive words with shared meaning makes the morphemic structure in Arabic orthographically transparent as well (Saiegh-Haddad, 2018).

Also, since Arabic letters are joined by ligaturing and clitics are added to words, then Arabic is considered to be highly agglutinative, which means one word could be the equivalent of an entire English sentence (Elbeheri et al., 2006). For example, the word (وَسَيَكْتُبونها) is equivalent to "and they will write it" (feminine) in English. The Arabic orthography follows a phonemic structure when it is voweled, as phonemes can be directly translated from graphemes, but follows a morphemic structure when it is unvoweled since the Abjad represents the morphological structure in a transparent way and allows the reader to recover the missing phonemes (Landerl et al., 2022; Perfetti & Harris, 2013; Taha & Saiegh-Haddad, 2017). Therefore, it is evident that in both the English and Arabic orthography, although letters and sounds are inconsistent (English) or there are missing sounds (Arabic), the morphological structure is consistent and transparent (Verhoeven & Perfetti, 2017). How the very different ways in which morphology is marked in the English and Arabic orthography influences a child's word reading strategies will be detailed in the next section.

2.4.5. How morphology helps with word reading in English

2.4.5.1. How previous theories of reading have neglected morphology's role in word reading

According to phase theory (Ehri, 2005b, 2014), mentioned in section 2.2.3, in the consolidated phase, the child has a store of many familiar words in his/her memory with fully analysed spellings due to repeated exposure to words. Children may decode words using larger chunks of letters (e.g. onset, rime, syllable, morpheme) as opposed to decoding individual letters and their sounds (Ehri, 2005b). For example, the word 'player' may be decoded by chunking the word into two morphemes: play + er, which is more efficient than decoding individual letters of the word reducing attention demands (Besner et al., 2009; Paap & Noel, 1991). Therefore, phase theory (Ehri, 2005b, 2014) assumes that morphemes are orthographic chunks like any other patterns (e.g. syllables) and that utilizing morphemes when reading tends to occur in a later phase of reading (Levesque et al., 2021). Phase theory (Ehri, 2005b, 2014) and dual-route theories (Coltheart et al., 2001; Jackson & Coltheart, 2001), mentioned in section 2.2.3, are related in the sense that the consolidated phase of reading development in phase theory is related to the direct route to reading words in dual-route theory while the partial and alphabetic phase of reading development in phase theory is related to the indirect route of reading within the dual-route theory (Levesque et al., 2021). However, what is missing in these theories is that they assume morphemes to be regular orthographic chunks like any syllable while in fact the next sections argue that morphemes are not regular orthographic chunks (as they are units that contain meaning), and play an important role in influencing word reading (Diependaele et al., 2012; Levesque et al., 2021; Nunes et al., 2012; Rastle, 2019).

2.4.5.2. Rastle's (2019) hypothesis

Rastle (2019) argues that the reason morphology has been ignored in theories of adult skilled reading, e.g. dual route theory (Coltheart et al., 2001; Jackson & Coltheart, 2001), is because such models have focused on monosyllabic and monomorphemic words. Amenta and Crepaldi (2012)'s review has shown evidence that skilled adult readers regularly utilize MA when recognizing words. At some point in the reading acquisition process, awareness of morphemes increases as a result of exposure to text and the development of orthographic representations of words as well as representations of morphemes in the lexicon (Georgiou et al., 2022; Rastle, 2019). Rastle's (2019) hypothesis states that since the English orthography preserves morphemes in its spelling, then this creates a relationship between mapping meaning directly from spelling, which probably occurs within the ventral reading pathway

(Taylor et al., 2013), mentioned in section 2.2.3.5. This was based on evidence from priming experiments that showed that when adults are presented with English words, readers are immediately able to segment morphemes while reading in a process called morpho-orthographic segmentation suggesting the use of morphemes in word recognition (Beyersmann et al., 2016; Davis & Rastle, 2010; Dawson et al., 2018; Diependaele et al., 2012; Lavric et al., 2012; Longtin et al., 2003; Rastle & Davis, 2008; Rastle et al., 2004). For example, studies have shown that a word such as ‘clean’ was recognized faster when a prime ‘cleaner’ was presented because the prime was morphologically and semantically related (Stanners et al., 1979). However, significant masked priming effects (where the prime is presented for a very short amount of time that it is not reported (Forster & Davis, 1984)) were shown for the target word ‘corn’ when a prime ‘corner’ was presented because the prime seemed like it was morphologically related although it was not semantically related either (Rastle et al., 2004). The priming effects for the (corn/corner) condition was significantly different when compared to control conditions where target and prime did not seem morphologically related (e.g. broth/brothel) suggesting that words are decomposed by adults in a process called morpho-orthographic segmentation during word recognition (Rastle et al., 2004). Another factor that influences word recognition is how frequent the morpheme stem is (e.g. darkness would be recognized because the stem dark is frequent) and another relates to how large the morphological family is (e.g. trust, distrust, untrustworthy form a morphological family derived from the stem: trust) (Bertram et al., 2000; Niswander et al., 2000). Also, evidence from neuroscientific studies that used functional magnetic resonance imaging (MRI) and magnetoencephalography (MEG) have shown that when the adult reader analyses morphemes, this occurs in the regions of the brain related to the ventral reading pathway (Devlin et al., 2004; Lewis et al., 2011), which is where readers map meaning directly from spelling. Whether or not children are able to process words using morpho-orthographic segmentation as well is a subject of debate as when 7-11 year old children were presented with English words they were not able to segment morphemes while reading (Beyersmann et al., 2012) while another experiment showed that that children age 7-9 are able to process morphemes in lexical decision tasks (Dawson et al., 2018). Children’s use of morphemes in the reading process and how exactly morphemes are accessed from the lexicon is still an unspecified area in the literature that theoretical models need to tackle (Rastle, 2019). The next section details a framework that attempts to tackle morphology’s role in word reading in children.

2.4.5.3. Morphological Pathways Framework

The first framework that attempts to outline the precise role of morphology within theoretical reading models is the recent morphological pathways framework (MPF) (Levesque et al., 2021). The MPF was based on the reading systems framework (Perfetti et al., 2005; Perfetti & Stafura, 2014), and extends it to include the multidimensional role of morphology and the different pathways that MA contributes to word reading, spelling, and reading comprehension (Levesque et al., 2021). The reading systems framework (Perfetti et al., 2005; Perfetti & Stafura, 2014) states that there are three sources of knowledge that are important when reading: linguistic, orthographic, and general knowledge. The process of decoding and identifying words uses these sources of knowledge along with pathways that link them to perceptual and long-term memory systems. Since this thesis focuses on the decoding aspect of reading only, the pathways relating to word reading only will be outlined in this section.

The MPF (Levesque et al., 2021) argues that morphemes are multidimensional. Researchers have identified three different dimensions of morphology related to word identification: morphological structure awareness, morphological decoding, and morphological analysis (Carlisle, 2000; Kuo & Anderson, 2006). Morphological structure awareness (MA) refers to the awareness of the morphemic structure of inflected and derived words (Carlisle, 2000) and is usually measured using written or oral judgement and analogy tasks, as mentioned in section 2.2.2. Morphological analysis is when the student uses the morphological structure of a word to understand its meaning (McCutchen & Logan, 2011). For example, when students see a new word, then morphological analysis helps to understand the meaning of the word from its structure and its morphemes (Carlisle, 2000). Morphological decoding is when a student is required to decode a word correctly using morphemes (Kuo & Anderson, 2006). For example, a student is given a set of words such as the word ‘misheard’, and the student must decode it by dividing it into the two morphemes ‘mis’ + ‘heard’ as opposed to incorrectly pronouncing it as ‘mish’ + ‘eard’ by decomposing the word into morphemes, this is also known as morphological decomposition (Verhoeven & Perfetti, 2011). A recent study examined all three dimensions of morphology in 8-year-old children and controlled for PA and vocabulary (Levesque et al., 2017). Results showed that MA influenced morphological decoding, morphological decoding influenced word reading, and word reading influenced reading comprehension. MA also influenced morphological analysis, and morphological analysis influenced reading comprehension. Since this thesis focuses on decoding and not reading comprehension, this section will outline the literature related to MA and morphological decoding.

Research has shown that MA explained significant variance in 8-year-old children's reading accuracy beyond PA and vocabulary (Kirby et al., 2012), was associated with decoding of inflected words in children in the fourth and fifth grade in Nagy et al.'s (2006) study, and was also associated with reading accuracy of complex words and decoding ability in students in the third grade (Levesque et al., 2017) suggesting that children use morphemes when reading. The MPF (Levesque et al., 2021) argues that children's processing of morphemes in English is separate to their processing of orthographic units. This is based on evidence from Nunes and Bryant's (2011) study where three subtests were developed. According to phase theory (Ehri, 2005b, 2014), in the consolidated phase, when children read words, the words are divided into units that are larger than GPCs, which improves children's efficiency while reading. These larger units can be graphophones (e.g. syllables) or morphemes. Graphophones do not have meaning and morphemes do (Nunes et al., 2012). The first subtest that was developed included a set of nonwords and real words which could be read by the child using GPCs such as *hop* and *sit.* The second subtest required reading of words and nonwords using units larger than GPCs and included words with the split digraph (where vowel sounds are split by a consonant) such as *taped* and *site.* Words were chosen in a way that even if the split digraph wasn't pronounced correctly, it would still result in pronouncing a real word like *tapped* and *sit.* That way children wouldn't get a clue that if words were not pronounced correctly a nonword would be the result such as *grap* instead of *grape,* and thus this set measured the use of orthographic units while decoding. The last subtest required reading of words and nonwords using morphemes such as *dishonest* and *mishammer.* This set measured decoding using morphemes. For example, if a student can decode the word 'dishonest' correctly by dividing it into the two morphemes 'dis' + 'honest' as opposed to incorrectly pronouncing it as 'dish' + 'onest' by decomposing the word into morphemes. Nunes and Bryant (2011) tested 7-10 year olds using these subtests and then 5 months later they were given standardized tests of intelligence and word reading. Results showed that the three subtests (controlling for age and IQ) predicted word reading independently suggesting that children used the three types of units to read: GPCs, graphophonic units larger than GPCs, and morphemes. The last subtest (using morphemes) was the strongest predictor of word reading. The study suggests that children use morphological decoding while reading words. Further evidence of the use of MA in reading was provided by Carlisle and Stone (2005). They tested children in the second, third, fourth, and sixth grade with two sets of words to read. The two sets were equal in length, frequency, and ended in the same spelling: one set was composed of words with two syllables and two morphemes (e.g. shady) and the other set comprised words with two syllables but one morpheme (e.g. lady). Results showed that the set with two morphemes were read faster by the younger age group than the set with one morpheme. Results also showed that all the age groups read the set with two morphemes more accurately than the set with one morpheme. This suggests that children recognize root morphemes that are frequent and that this makes reading easier and highlights the distinct roles that morphemic units and syllabic units have on children's word reading (Carlisle & Stone, 2005).

MA has also been shown to contribute to reading fluency, above and beyond the effects of PA, of students in the eighth and ninth grade in Nagy et al.'s (2006) study. It has also been shown among 9-12 year old students that when given sets of low frequency whole words, words with high frequency bases (e.g. dryness) were read faster than words with low frequency bases (e.g. cohesiveness) suggesting that children access the morphological structure of words while reading and that this influences the speed of reading (Deacon et al., 2011). Morphologically complex words usually have fewer morphemes than syllables. Therefore, if children who use morphemes when reading, then they might be more fluent readers than those who just use syllables. This was shown in Nunes et al.'s (2012) study where 8–9-year-old children were given the same subtests from Nunes and Bryant's (2011) study (a subtest that required reading words and nonwords using units larger than GPCs such as syllables and a subtest that required reading words and nonwords using morphemes). Results showed that two units (decoding using orthographic units vs morphemes) made independent contributions to reading fluency, and that decoding using morphemes was a stronger predictor of reading fluency. This suggests that children who use morphemic units (of which there are fewer than syllables) while reading morphologically complex words would read faster and more efficiently than children who don't.

The MPF (Levesque et al., 2021) argues that since MA is multidimensional then it is divided between the linguistic system, orthographic system, and lexical representations (see Figure 4). Having general knowledge of the orthographic structure of morphemes is part of the orthographic system as part of central orthographic processes, which are included in Figure 4, Panel B, as part of word identification processes. Being able to explicitly manipulate morphemes in speech is part of the linguistic system, which is part of the linguistic and writing system knowledge as seen in Figure 4, Panel A (Levesque et al., 2021). The lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002) suggests, as mentioned in section 2.2.3, that knowledge of meaning (morphemes) increases quality of lexical representations and influences the ability to retrieve other aspects of lexical information such as spelling and sound. Hence, in the MPF (Levesque et al., 2021), morphology has been added under lexical representations of words, which are part of word identification processes, as shown in Figure 4, Panel B. The morpheme has also been included as a grain size unit that is an important part of the orthographic system that makes up the linguistic and writing system knowledge seen in Figure 4, Panel A. The MPF (Levesque et al., 2021) argues that morphology influences reading through implicit and explicit processes, which involve the three dimensions: morphological structure awareness, morphological decoding, and morphological analysis. These three dimensions are considered distinct (Deacon et al., 2017; Levesque et al., 2017) and are represented with different colours of lines in Figure 4. Morphological decoding is argued to be exactly how morphology influences word reading by providing a link from the knowledge of morphemes to being able to decompose them while reading morphologically complex words. The MPF (Levesque et al., 2021) argues that morphological structure awareness helps with word identification processes in two ways. One way is that it helps to connect the linguistic system with lexical representations through morphological analysis and the use of meaning to support word reading (Baumann et al., 2002; Pacheco & Goodwin, 2013) (see green dotted line in Figure 4). The other way is that it helps to connect morphemes in spoken language to morphemes in written language (see solid blue line), which helps with morphological decoding.

To sum up, the MPF (Levesque et al., 2021) attempts to outline the multiple roles morphology plays in word reading and is the first framework that attempts to do this. As morphology is an area that requires further research, there are some aspects to the framework that are still unknown (Levesque et al., 2021). For example, the connecting of morphemes from spoken to written language is unnamed in the MPF because it is still not certain whether this process is part of morphological decoding or separate. It is also still unknown whether morphological analysis and morphological decoding are part of explicit or implicit morphological processes (Levesque et al., 2021; Nagy et al., 2014). Levesque et al. (2021) also warn that the MPF was based on evidence in English, and that it may only apply to morphophonemic and opaque alphabetic orthographies like English (Carlisle & Stone, 2005; Seymour et al., 2003). Therefore, this thesis will focus on morphological structure awareness

(MA), which is a dimension that has been shown to be a universal skill related to reading (Verhoeven & Perfetti, 2022), as mentioned in section 2.2.2. How morphology helps with word reading in Arabic will be detailed in the next section.

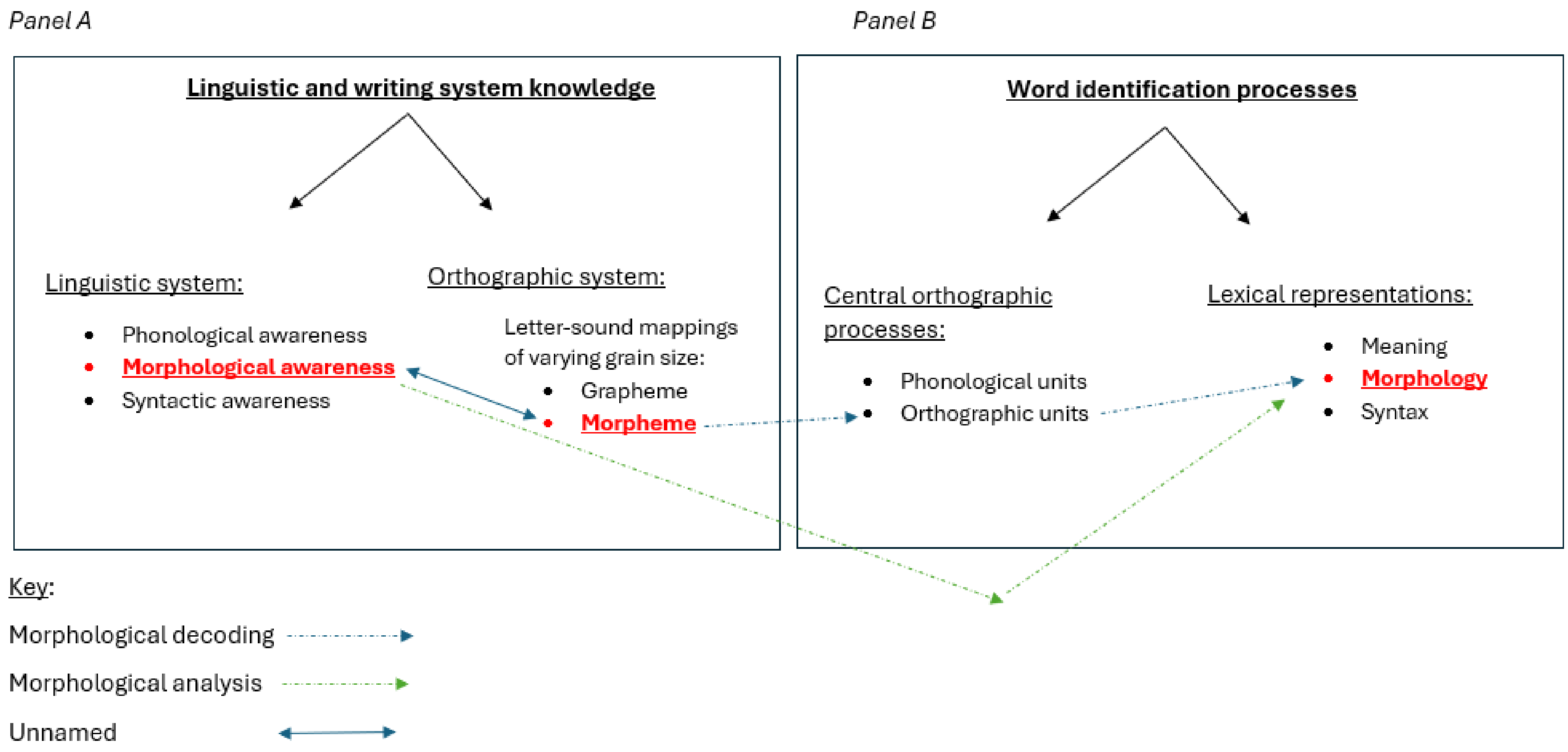

Figure 4. Diagram adapted from Levesque et al.'s (2021) Morphological Pathways Framework, Panel A shows linguistic and writing system knowledge, Panel B shows word identification processes involved in word reading, summarizing how MA helps with word reading a) through morphological analysis by connecting the linguistic system with lexical representations through the use of meaning to support word reading b) through morphological decoding by connecting morphemes in spoken language to morphemes in written language

2.4.6. How morphology helps with word reading in Arabic

Research from behavioural experiments (Boudelaa, 2014; Boudelaa & Marslen-Wilson, 2005; Mahfoudhi, 2007), an experiment on an Arab patient with brain damage (Prunet et al., 2000), and research using neuroimaging techniques (Boudelaa et al., 2010) have suggested that native Arabic readers store words in the orthographic lexicon according to the root and pattern morphemic structure. This evidence supports lexical processing theories that assume that complex words are accessed from the lexicon as separate morphemes (Caramazza et al., 1988; Taft, 1981). Given that Arabic words are thought to be organized in the lexicon according to the morphemic structure, and that the orthography presents this morphemic structure in a transparent way, MA may help the reader recognize familiar words and guess the meanings of new words (Mahfoudhi et al., 2010). This highlights the important role of morphology in Arabic reading because the letters of the root and the letters patterns of the word pattern are constantly repeated, then this influences the development of orthographic representations which in turn influences word reading (Perfetti, 1992; Share, 1999). A study examining the relationship between MA (using a written judgement and production task) and reading among Palestinian Arabic-speaking students in the 3rd, 6th, 9th, and 12th grade found that MA predicted voweled reading accuracy and reading comprehension across all grade levels (Abu-Rabia, 2007). A similar study examining the relationship between MA and reading among Palestinian Arabic-speaking students in the 6th and 8th grade showed that MA predicted reading accuracy in unvoweled words as well (Abu-Rabia & Abu-Rahmoun, 2012). Taha and Saiegh-Haddad's (2017) study showed that root and word-pattern awareness was evident in second graders, with evidence of root awareness developing earlier than word-pattern awareness across grade levels. However, the tasks used in this study were judgement tasks to judge whether words come from the same root or word-pattern. Another study developed a psychometrically valid measure of root awareness (presenting the child with a target word and six-word choices and asking them to circle words that come from the same family as the target) (Tibi et al., 2019). The task was administered on Arabic-speaking 8-year-old children in the UAE and the study found that this measure of root awareness highly predicted reading accuracy, reading fluency, and reading comprehension controlling for vocabulary (Tibi et al., 2019). This highlights the importance of the root in Arabic morphology and reading. MA has been linked to several reading outcomes in several other studies, for example word reading accuracy (Abu-Ahmed et al., 2014; Abu-Rabia, 2007; Saiegh-Haddad & Taha, 2017; Tibi, 2016; Tibi et al., 2020; Tibi & Kirby, 2017, 2019), single word reading fluency (Asadi et al., 2017; Schiff & Saiegh-Haddad, 2018), reading comprehension (Layes et al., 2017; Mahfoudhi et al., 2010) and spelling (Saiegh-Haddad & Taha, 2017; Taha & Saiegh-Haddad, 2017).

A model of Arabic word reading in development (MAWRID) has been proposed and argues that reading development in Arabic is influenced by three factors: vowelization, derivational morphology, and diglossia (Saiegh-Haddad, 2018). Children start to read using phonological decoding mechanisms by converting graphemes (letters and diacritics) into sounds in the voweled version of the Arabic script. The child is then exposed to unvoweled script starting from around the third grade (Mahfoudhi et al., 2010). The children then start to use the transparent morphemic structure (consonants and long vowels) in the orthography to provide phonological information (Saiegh-Haddad, 2018). Since Arabic has a specific morphemic structure, mentioned in section 2.4.3, this allows the reader to compensate for the missing phonological information in the unvoweled orthography (Saiegh-Haddad & Geva, 2008). This mechanism is unique to the Arabic orthography and develops as a result of the transparent structure of morphemes in a word and the organization of the native Arabic speakers' lexicon around the root and word pattern (Boudelaa, 2014; Saiegh-Haddad & Henkin-Roitfarb, 2014).

Psycholinguistic grain size theory (Ziegler & Goswami, 2005), discussed in section 2.3.2, argues that reading development in different orthographies is influenced by availability, transparency, and granularity (Ziegler & Goswami, 2005). This theory was developed based on alphabetic orthographies and refers to grain sizes as different sizes of sound structures. Saeigh-Haddad (2018) extends this theory and argues that, for the theory to fully apply to the Arabic orthography, then grain sizes could also be other linguistic units such as morphemes. According to this view, since diacritics (provide short vowel sounds) are not available in unvoweled words, and since the morphemic structure is transparent in the orthography and is available in the lexicon, then the morpheme is used as a grain-size to process unvoweled words (Saiegh-Haddad & Schiff, 2016; Schiff & Saiegh-Haddad, 2018). The reader uses two decoding mechanisms at the same time with different linguistic units as grain sizes: a grapheme-based (letters and diacritics) phonological one and a letter-based (consonants and long vowels) morpho-orthographic one in older and skilled readers (Saiegh-Haddad, 2018; Saiegh-Haddad & Schiff, 2016; Ziegler & Goswami, 2005). Schiff and Saiegh-Haddad (2017) found that Arabic-speaking children in Israel read voweled words more accurately than unvoweled words at ages 7 and 9. However, at age 11, children were found to read unvoweled words more accurately than voweled words. This suggests that Arabic-speaking children may rely on diacritics when they are young to provide phonological information, but once they start to store more orthographic representations in memory, they then don't need diacritics to read words and rely more on morpho-orthographic processes to read. Evidence from a study that examined the effects of a phonological intervention versus a morphological intervention aimed at two groups of second, fourth, and sixth grade Arabic-speaking students in Israel showed that both interventions improved word reading in voweled and unvoweled Arabic as well as non-word reading (Taha, 2009). The older children benefited from the morphological training to a greater extent than the phonological training while the morphological intervention showed higher improvement in unvoweled reading than voweled reading. Students who have not acquired enough morphological awareness, awareness of syntax, vocabulary, and are not able to use clues from the context would struggle in the shift to unvoweled text (Saiegh-Haddad, 2018).

Most of the reading models discussed thus far, and the role morphology plays in them in both English and Arabic, have been developed based on monolingual readers. These models highlight the importance of both phonology and morphology. The next section discusses the complex processes that occur when a bilingual child is learning to read in two languages.

2.5 Bilingual reading

2.5.1. Definition and types

A bilingual child is a child that is exposed to more than one language, but there are different types of bilingual child populations (Paradis, 2007). A lot of the research that has taken place in North America is related to two types: a bilingual child who is learning to read and write in English (L1) most of the time and then learns to read and write in a second language such as Spanish (L2) (Paradis, 2007). The other type is a child that speaks a language other than English at home such as Spanish (L1) and then learns to read and write in English (L2) only at school most of the time (Paradis, 2007). The latter type of bilingual children's L2 skills develop with more schooling, and L2 skills start to become stronger than their L1 skills so this population of bilinguals is usually called unbalanced bilinguals (Polinsky, 2015). The bilingual child population in Kuwait is quite different and relates to children learning to read and write in both Arabic (L1) and English (L2) at the same time while English (L2) is used as the medium of instruction for most other subjects, also called a bilingual and biliterate population (Zhang & Ke, 2020). Children in bilingual schools in Kuwait could be considered simultaneous bilinguals, which are children exposed to two different languages from birth, or sequential bilinguals, who are exposed to a second language at age three onwards (Paradis et al., 2011). The skills acquired by these children in these two languages depend on how much of each language the child is exposed to, how consistently, and in what context (Genesee & Nicoladis, 2007). Research has shown that although simultaneous bilinguals' exposure to each language is lower than that of monolinguals' to their sole language, the bilinguals eventually achieve similar vocabulary growth to the monolinguals (Pearson et al., 1997). There is scant research that has examined biliterate child populations, and is interesting to examine this cohort of children as they are learning to read in different orthographies at the same time (McBride & Mohseni, 2023). Theoretically speaking, children learning to read in Arabic and English at the same time, as mentioned in previous sections, are reading in two orthographies that are completely different yet still alphabetic (Stuart & Stainthorp, 2016), are considered orthographically deep in different ways (Verhoeven & Perfetti, 2017), and both preserve the morphemic structure despite having very different morphological structures (Saiegh-Haddad & Geva, 2008). Biliteracy may influence the development of metalinguistic skills (phonological and morphological) within each language and their association to word reading as children reading in different orthographies may rely on different types of decoding (McBride & Mohseni, 2023). For example, reading in Arabic is argued to rely more on visual and orthographic information than reading in English. Examining biliterate populations also allows to test whether the theories related to morphology and reading that were based on monolingual readers mentioned in sections 2.4.5 and 2.4.6 within each language (English and Arabic) apply to these bilingual children or whether they show a novel pattern of association due to the transfer of skills between the two languages. Sections 2.5.3 and 2.5.4 discuss theories and research related to cross-linguistic transfer. The next section discusses theories of bilingual reading.

2.5.2. Theories of bilingual reading

If children are learning to read and write in two languages at the same time, then one assumes that the universal skills of reading are related in both languages (Martinelli & Brincat, 2020). This idea serves as the basis of the central processing hypothesis (Geva & Siegel, 2000), which argues that learning to read and write in two languages (L1 and L2) depend on universal cognitive and linguistic skills that transfer between the languages. Therefore, PA is an important predictor of reading not only in L1 but in L2 as well (Adams, 1990; Ball, 1993; Durgunoğlu, 2002). However, sometimes these cognitive and linguistic skills relate to reading in a different way depending on the orthography (Bialystok et al., 2005; Durgunoğlu, 2002; Gholamain & Geva, 1999). This serves as the basis for the script-dependant hypothesis (Geva & Siegel, 2000) which argues that learning to read develops differently across orthographies that vary in their orthographic depth. As mentioned in section 2.3.2, readers may rely on different grain sizes while reading (Ziegler & Goswami, 2005) as well as different units (phonemic or morphemic) depending on the orthography (Share & Levin, 1999).

Cummins (1978) argues that the reason why bilingual readers may show an advantage in linguistic skills is that being bilingual may increase the child's metalinguistic awareness (Cenoz, 2003; Hirosh & Degani, 2018). Metalinguistic awareness is the child's ability to consciously analyse language and components of language independent of meaning (Capone & Shulman, 2014; Gombert, 1992). Children exposed to two languages are also argued to have stronger linguistic skills (Bialystok & Herman, 1999) as a result of cross-linguistic transfer (Kuo & Anderson, 2010). For example, a study compared PA skills in monolingual and bilingual Arabic-English 5-6 year old children in Kuwait and found that the bilingual students scored higher than the monolingual students on PA tasks in Arabic (AI-Sulaihim, 2014). The next section will discuss theories and research related to cross-linguistic transfer.

2.5.3. Theories of cross-linguistic transfer

Bialystok and Barac (2013) argue that being exposed to two different linguistic systems is an advantage to the reader because of the transfer of these shared skills, and this may explain why some bilinguals perform better than or equal to monolinguals on word-level reading skills. The linguistic interdependence hypothesis, presented by Cummins (1979), argues that the transfer of linguistic skills from a first language to a second language (L1 to L2) occurs routinely in bilinguals regardless of the orthography, and highly developed reading skills in L1 can be transferred to L2. However, according to the threshold hypothesis (Cummins, 1991) which proposes that before a child starts school, if first language (L1) skills, usage, and vocabulary are developed outside of school, and the child is exposed to a second language (L2) as a means of language instruction, then the child will be able to be highly proficient in L2 without affecting L1 proficiency. However, if L1 is not developed at the point when exposure to L2 occurs, then this will prevent the development of L1 as well as L2.

Researchers have examined the transfer of PA skills (L1 to L2) across languages varying in degrees of orthographic consistency, and evidence was found for the transfer of PA skills between English and French (Chiang & Rvachew, 2007), Spanish and English (Cisero & Royer, 1995; Durgunoğlu et al., 1993; Sun-Alperin & Wang, 2011), English and Hebrew (Wade-Woolley & Geva, 2000), and English and Arabic (AI-Sulaihim, 2014; Farran et al., 2012; Saiegh-Haddad & Geva, 2008).

Research on bilingual programs in North America compared to English-only programs has shown that including minority children's L1 in the program did not affect the proficiency achieved in English (L2) formal academic learning (Cummins, 1981). Other studies looking at the French immersion programs in Canada showed that English-speaking children receiving instruction in French (L2) and then integrating English (L1) instruction in later grades had equivalent reading skills in English when compared to English monolinguals receiving their instruction in English only (Barik & Swain, 1975; McDougall & Bruck, 1976). Also, studies examining bilingual Portuguese-Canadian and Arab-Canadian students aged 9-12 years showed no differences in bilinguals' English word reading and non-word reading skills when compared to monolingual English-speaking children (Abu-Rabia & Siegel, 2002; Da Fontoura & Siegel, 1995).

If L1 skills are developed outside of school, exposing a child to a second language as a means of language instruction has not affected the proficiency achieved in both languages (Cummins, 1979). Being exposed to two language systems can be an advantage to the reader as linguistic skills can be transferred from L1 to L2 (Bialystok & Barac, 2013; Cummins, 1979). Phonological skills, which are important in both L1 and L2 (Adams, 1990; Ball, 1993), have shown to transfer across several languages regardless of the differences between orthographies (Farran et al., 2012; Saiegh-Haddad & Geva, 2008; Wade-Woolley & Geva, 2000). Whether bilinguals show an advantage in terms of their morphological skills and whether morphological skills transfer across languages will be discussed in the next section.

2.5.4. Morphology in bilinguals

Two studies (Barac & Bialystok, 2012; Bialystok et al., 2014) have shown an advantage in the performance of bilinguals in comparison to monolinguals, matched on language proficiency, on the Wug Test, which was created by Berko (1958) to assess morphological development using non-words. The Wug Test is like the sentence completion task (Carlisle, 2000), discussed in section 2.2.2, but requires the child to complete the sentence with the correct morphological form using non-words. For example, “Here is a wug. Here is another wug. How many are there? There are two ___” (Berko, 1958). The correct response would be ‘wugs’. An additional study examining inflectional morphology in Italian-speaking children found an advantage for morphological skills in bilinguals (Vender et al., 2018). These studies provide evidence that being exposed to two different linguistic systems may be beneficial to the reader (Bialystok & Barac, 2013), and that bilingual readers may show an advantage in linguistic skills such as morphological skills.

A small number of studies have examined whether morphological skills transfer to reading across languages (Deacon et al., 2007; Farran et al., 2012; Saiegh-Haddad & Geva, 2008; Schiff & Calif, 2007). Only one study has seen transfer of morphological skills in both directions in 6–8-year-old Canadian-French students attending the French immersion program where performance on an oral inflectional morphology task was measured (Deacon et al., 2007). Results showed that English MA predicted French word reading, and French MA predicted English word reading after controlling for verbal and nonverbal ability, PA, and MA in the same language. Another study examined the transfer of MA in Spanish-English bilinguals, and two measures of derivational morphology were used that were both oral and written (Ramirez et al., 2010). Results showed that MA in Spanish (L1) predicted word reading in English (L2) in this direction only. An additional study examined Canadian-Arabic bilingual students who were English-dominant, and two measures of derivational morphology were tested using the oral modality (Saiegh-Haddad & Geva, 2008). One task required the child to judge morphological relationships of words while the other task required the child to break down derived words into smaller units. Results showed that there were no correlations between the participants’ performance on the MA tasks in English and Arabic, which was also seen in Farran et al.’s (2012) study in which only the oral morphological relatedness task was used as a measure of MA. The two studies (Farran et al., 2012; Saiegh-Haddad & Geva, 2008) argued that no correlation was found between the two languages because English and Arabic have very different morphological structures, and, unlike the alphabetic orthographies in the studies described above, MA may be a linguistic skill that is specific to each language. However, the two studies involved small sample sizes with specific characteristics that may not be generalisable to other Arabic-English bilinguals, especially not the bilingual population in Kuwait, as mentioned earlier, is a different type of bilingual and biliterate population. Saiegh-Haddad and Geva (2008) argue that the inconsistency of the results of cross-linguistic transfer of MA skills across studies could be because of the different tasks used (e.g. judging morphological relationships, decomposition, analogy) to measure different elements of MA skills (inflectional and derivational) in previous studies as well as the different languages examined.

Finally, a recent study has examined 10-year-old biliterate children in Singapore who were learning to read in both Chinese and English (Zhang & Ke, 2020). Zhang and Ke compared the contribution of English phonemic decoding (using a nonword reading task) and English morphological decoding fluency (using a similar task used in Nunes et al. (2012) where words like 'misheard' must be decoded by dividing it into the two morphemes 'mis' + 'heard') to English reading comprehension in two groups of students. Both groups included biliterate students from the same school learning to read in Chinese and English, but one group contained students whose home language was English, and the other group contained students whose home language was Chinese. Results showed that, for the group whose home language was English, morphological decoding fluency was a significant (and higher effect size) predictor of reading comprehension while, for the group whose home language was Chinese, it wasn't. Zhang and Ke argue that the results perhaps indicate that students being exposed to English to a higher degree, due to it being the home language, may develop more morphological representations and therefore have stronger lexical quality (Perfetti, 2007) than students who are less exposed. Zhang and Ke also argue that the results may indicate that perhaps the process of using morphological decoding while reading in biliterate children whose home language is not English is delayed compared to English monolingual children such as those in Nunes et al.'s (2012) study. This is in line with McBride and Mohseni's (2023) argument that language exposure may influence biliteracy and student's reading strategies and what type of decoding they rely on. Finally, Zhang and Ke (2020) argue that the SVR has described decoding as an important aspect of reading comprehension, but has failed to indicate that morphological decoding is an important aspect of decoding, adding the SVR to the list of theoretical models that have failed to include the important role morphology plays in English reading, as mentioned in section 2.4.5.1.

A small number of studies have shown an advantage in bilinguals' morphological skills compared to monolinguals' (Barac & Bialystok, 2012; Bialystok et al., 2014; Vender et al., 2018). This could be due to an advantage in metalinguistic awareness in bilinguals as well as the transfer of linguistic skills across languages (Cummins, 1978, 1979). Studies investigating whether morphological skills transfer across languages regardless of the orthography have shown mixed results (Deacon et al., 2007; Farran et al., 2012; Saiegh-

Haddad & Geva, 2008; Schiff & Calif, 2007) and is still not established as clearly as it has been with regard to the transfer of phonological skills across different orthographies (Farran et al., 2012; Saiegh-Haddad & Geva, 2008; Wade-Woolley & Geva, 2000). More studies should examine biliterate students and the role morphology plays in word reading as students reading in different orthographies may show different reading strategies (McBride & Mohseni, 2023). The evidence, discussed thus far, is related to linguistic skills in bilingual children who are typically developing (TD). Whether children with RD also show an advantage in linguistic skills due to being exposed to two languages will be discussed in section 2.6.4. Although this thesis does not examine cross-linguistic transfer and only focuses on within language associations between MA and reading, it was important to review the literature related to cross-linguistic transfer as it relates to the section 2.6.4 that addresses bilingual education for children with RD. The definition of reading difficulties, types, and the nature of word reading difficulties in monolingual English and Arabic children will be discussed first in the next section.

2.6 Reading difficulties

2.6.1. Definition and types

As mentioned in the introduction chapter, reading difficulties (RD) and dyslexia are terms used interchangeably in Kuwait. There are many different definitions of dyslexia, but all definitions include having a difficulty with word reading (Stuart & Stainthorp, 2016). Developmental dyslexia is a type of specific learning difficulty where the individual has difficulty with accurately and fluently reading words and difficulty spelling words (Rose, 2009). These individuals can have typical or atypical intelligence and usually show “difficulties in PA, verbal memory, and verbal processing speed” (Rose, 2009, p. 9). Children with dyslexia may also show weaknesses in vocabulary skills (Snowling & Melby-Lervåg, 2016). Although children with RD show weaknesses in these skills, the exact cause of dyslexia is still unknown (Norton et al., 2014), but most researchers have agreed that the cause is neurological, which means it relates to the brain and nerves (Fisher & DeFries, 2002). Word reading difficulties are not the same in all children with dyslexia as evidence has shown different profiles of strengths and weaknesses (Castles & Coltheart, 1993; Manis et al., 1996; McArthur et al., 2013; Peterson et al., 2013). Diagnosing a child with dyslexia is a complex process that includes, for example, the child taking a standardized reading test, and if the child scores below a pre-determined score, or cut-off point, then he/she would receive a diagnosis of dyslexia (Stuart & Stainthorp, 2016). There has been a large debate related to whether all children, irrespective of their general cognitive ability, who show word reading difficulties should be diagnosed with dyslexia, and what the cut-off point is for diagnosis (Elliott, 2020). Children who have difficulties with word reading, but whose reading scores are slightly above the cut-off point wouldn't receive a dyslexia diagnosis and therefore would not be able to benefit from provisions, targeted interventions to improve reading skills, and financial support that come alongside a diagnosis of dyslexia (Elliott, 2020; Stuart & Stainthorp, 2016). Therefore, all children showing word reading difficulties should be supported either way regardless of whether they obtain a dyslexia diagnosis or not (Stuart & Stainthorp, 2016). The way they are supported is to identify their areas of weaknesses to provide intervention targeting these weaknesses (Galuschka et al., 2014). For example, since children with RD have shown weaknesses in PA, interventions targeting phonological skills have shown improvement in reading skills (Galuschka et al., 2014).

It is difficult to categorize children with RD into specific types because, as mentioned earlier, they are a heterogeneous group (Castles & Coltheart, 1993; Manis et al., 1996; McArthur et al., 2013; Peterson et al., 2013). However, based on the SVR (Gough & Tunmer, 1986), mentioned in section 2.2.3, researchers have attempted to group readers into four types of groups known as the quadrant model of reading (Aaron, 1997; Catts et al., 2003; Ebert & Scott, 2016). The first group of readers have been labelled 'good readers' who have good word recognition and good language comprehension. The second group of readers have good language comprehension, but poor word recognition and they have been labelled 'poor readers,' which represents children with dyslexia. The third type of readers have good word recognition, but poor language comprehension and they have been labelled 'poor comprehenders' and include children with hyperlexia, which is a diagnosis given to children with poor written and oral comprehension skills but outstanding word recognition (Healy, 1982). The final subgroup is labelled 'mixed poor readers' and they have poor word recognition and poor language comprehension (Aaron, 1997; Catts et al., 2003; Ebert & Scott, 2016). The quadrant model of reading (Aaron, 1997; Catts et al., 2003; Ebert & Scott, 2016) has received criticism in the sense that it does not include other constructs that are related to reading ability, is based on random cut-off points and imprecise assessment of constructs, and that sometimes there are students with good word recognition and language comprehension but have poor reading comprehension skills and they would not fit in any of the subtypes defined by the model (Duke & Cartwright, 2021; Hoover, 2023). This thesis focuses on children who have received a diagnosis of dyslexia in which these students were showing poor word recognition skills despite developing normally and receiving appropriate literacy instruction (Tunmer & Greaney, 2010). The next section discusses the different theories to help explain these reading difficulties.

2.6.2. Theories of reading difficulties

As mentioned in section 2.2.2, before learning to read, children have phonological representations stored in memory that they acquired from their spoken language and are able segment words into syllables or phonemes (Ehri & Nunes, 2002). These phonological representations are important for reading because they help translate letters into sounds (Goswami, 2000; Vellutino et al., 2004). However, children with RD are unable to respond to such word segmentation tasks suggesting weaknesses in their PA skills, which has been considered the main explanation behind their inability to translate letters into sounds and their reading difficulties (Hulme et al., 2015; Joanisse et al., 2000). There is a large debate about children with RD relating to whether the phonological representations are initially not stored well in memory, or whether the phonological representations are intact and it is the inability to retrieve them that is the explanation behind the reading problems (Blomert et al., 2004; Ramus & Szenkovits, 2008). The latter option is the position of the phonological deficit hypothesis (Snowling, 2000), which argues that weaknesses in phonological processing skills hinders the ability to properly retrieve phonological representations, which in turn influences grapheme-phoneme conversion and ultimately leads to reading difficulties.

Other researchers have argued that having a phonological deficit is not the main explanation behind reading difficulties, and not all children with reading difficulties have a phonological deficit (Wolf & Bowers, 1999). Several researchers argue that there is a weak correlational relationship between PA and RAN across languages (Albuquerque, 2012; Katzir et al., 2008; Moll et al., 2009; Torppa et al., 2012), that RAN and PA load on separate factors using factor analysis (Powell et al., 2007), and that naming speed deficits should be considered independently of phonological deficits (Wolf & Bowers, 1999). Wolf and Bowers (1999) proposed the double-deficit hypothesis (DDH), which states that there are three types of word reading disabilities as a result of deficits in two sources of reading impairment: phonological processing and naming speed. The first type (A) is when the reader has deficits in phonological processing and typical naming speed. The second type (B) is when the reader has deficits in naming speed and typical phonological processing. Finally, the third type (C) is when the reader has deficits in both naming speed and phonological processing. Evidence has shown that type A tend to have weaknesses in reading accuracy and comprehension (Lovett, 1984, 1987). Evidence has also shown that type B tend to have weaknesses in reading fluency and orthographic processing (Bowers & Wolf, 1993; Wolf, 1999). Finally, type C tend to have weaknesses in all areas of word reading and tend to perform worse than type A and B on literacy tasks (Wolf & Bowers, 1999).

Some researchers have criticized the DDH arguing that phonological processing and RAN are correlated, it is difficult to separate their individual effects, and that naming speed deficits are not as clear as phonological deficits (Pennington et al., 2001; Vukovic & Siegel, 2006). A meta-analysis of studies (Vukovic & Siegel, 2006) argues that the reasons evidence was not found for independent phonological and RAN deficits in these studies were due to differences in sample size, languages, orthographies, how dyslexia is defined, and how cut-off scores are set to identify subtypes of dyslexia. Studies in other orthographies such as Spanish (Escribano, 2007) and German (Wimmer et al., 2000) did not find evidence that phonological deficits influence reading accuracy in these consistent orthographies. Therefore, it was difficult to draw conclusions about the validity of the DDH. A study examining whether the DDH groups can be found in Arabic-speaking children in the third and fourth grade in Israel has shown that the three groups were found, RAN was related to reading time, and the findings support the argument that PA and RAN should be considered as independent deficits (Asadi & Shany, 2018; Wolf & Bowers, 1999). However, many other inconsistencies with the hypothesis were found, and orthographic processing was argued to be considered a core deficit due to the complexity of the Arabic orthography (Asadi & Shany, 2018). Additional studies examining 10 year old Arabic-speaking children with RD in Israel (Abu-Rabia & Darawshe, 2024) and 9 year old Arabic-speaking children with RD in Algeria (Layes et al., 2022) also argue that children with RD show deficits in PA, RAN, and orthographic processing. Since children with word reading difficulties are diverse, it is very difficult to group them under specific types using arbitrary cut-off points especially in different orthographies (Rose, 2009; Stuart & Stainthorp, 2016). Recent research has examined multiple-deficit models, where multiple sources of deficits are considered, and found them to be more fitting of profiles of children with reading difficulties (Catts et al., 2017; McGrath et al., 2020; O'Brien & Yeatman, 2021; Pennington et al., 2012; Ring & Black, 2018; van Bergen et al., 2014).

Multiple deficit models (Catts et al., 2017; McGrath et al., 2020; O'Brien & Yeatman, 2021; Pennington et al., 2012; Ring & Black, 2018; van Bergen et al., 2014) propose that a child with RD might have different strengths and weaknesses than another child with RD, and that there is no deficit that is always the explanation behind reading difficulties. However, a reading difficulty is a result of a combination of different factors such as factors relating to cognitive skills and linguistic skills (Cain et al., 2017). These skills combine with each child's circumstances in relation to their SES, their emotional wellbeing, the orthography they are learning in, and the instructional methods their schools utilize resulting in an individual child's experience with RD that is different to another child's (Catts et al., 2017; McGrath et al., 2020; O'Brien & Yeatman, 2021; Pennington et al., 2012; Ring & Black, 2018; van Bergen et al., 2014). The next section details how learning in a certain orthography may influence the nature of the child's reading difficulty and how certain skills are considered universal to RD regardless of the orthography.

2.6.3. Reading difficulties in the English and Arabic orthography

Verhoeven et al. (2019) have examined 11 orthographies including English and Arabic and have outlined that the main weakness found in children with RD in these orthographies is phonological. As mentioned in section 2.2.2, skills like being aware of sounds, different sound boundaries within a word, letter sound knowledge, using letter sound knowledge to phonologically recode words to eventually store these words as orthographic representations in memory, and finally being able to achieve word reading fluency are all essential and universal skills for word reading (Verhoeven & Perfetti, 2022). Weaknesses in phonological skills in children with RD influence the weaknesses found in the aforementioned skills (Verhoeven et al., 2019).

As discussed above, weaknesses in phonological processing are thought to be the main cause of word reading difficulties in English (Snowling, 1980, 2013; Stanovich & Siegel, 1994; Vellutino et al., 2004; Vellutino & Scanlon, 1987; Wagner & Torgesen, 1987). Reading and spelling difficulties in Arabic are similar to English in the sense that evidence has found phonological variables to predict differences in literacy skills (Abu-Rabia et al., 2003; Elbeheri & Everatt, 2007; Layes et al., 2015; Saiegh-Haddad & Taha, 2017). However, most of the theories relating to reading difficulties, mentioned in section 2.6.2, have been developed based on English and other alphabetic orthographies, which make them 'Anglocentric' (Daniels & Share, 2018; Moore et al., 2023). There are unique aspects in the Arabic orthography such as the use of diacritics and the presence of diglossia that influences children with RD's word reading (Schiff & Saiegh-Haddad, 2017). A study examining a group of 11-year-old children with RD in Israel found that reading accuracy and fluency for this group was equivalent to the levels of a 7-year-old TD group and no differences between reading accuracy and fluency for voweled words and unvoweled words was found for the RD group (Schiff & Saiegh-Haddad, 2017). As mentioned in section 2.4.6, the same study found that 7-year-old TD children's reading accuracy was higher for voweled than unvoweled words. However, unvoweled words are read faster and more accurately than voweled words in 11 year old TD children due to the increased reliance on morpho-orthographic processes while reading as opposed to phonological processes (Saiegh-Haddad, 2018). Schiff and Saiegh-Haddad argue that because children with RD have weaknesses in phonological skills, then it does not make it easy for RD children to phonologically recode voweled words. Therefore, because children with RD have trouble with phonologically recoding voweled words, then this influences the lack of orthographic representations and morphemes that are stored in memory (Share, 2008b), which in turn influences the ability to use morpho-orthographic processes to decode unvoweled words (Saiegh-Haddad, 2018). Recent recommendations have been proposed to change the shift from voweled to unvoweled text based on the strengths and weaknesses of the child, and not based on an age or grade level cut-off for both RD and TD students to reduce the rate of learning poverty in Arabic in the region (Gregory et al., 2021).

Another aspect that influences Arabic word reading in children with RD is diglossia. As mentioned, in section 2.3.6, diglossia influences the development of PA which influences word reading (Saiegh-Haddad, 2003, 2004, 2005). Schiff and Saiegh-Haddad's (2017) study also found that 11-year-old children with RD in Israel scored higher on reading accuracy and fluency for spoken Arabic words than Standard Arabic words. Another study examining 8-year-old good and poor decoders in the UAE found that the poor decoders were not able to read voweled words that they were unfamiliar with orally, while PA was the only predictor of reading accuracy in voweled words (Tibi & Kirby, 2019). This may suggest that children with RD are more affected by diglossia, which poses an additional challenge for children with RD learning to read in Arabic.

2.6.4. Morphology in children with reading difficulties

It has been established that children with RD show deficits in PA skills (Abu-Rabia et al., 2003; Elbeheri & Everatt, 2007; Layes et al., 2015; Melby-Lervåg, 2012) and RAN skills (Araújo & Faísca, 2019; Shany et al., 2023) in both Arabic-speaking and English-speaking children with RD. There is less research that has focused on MA in children with RD (Georgiou et al., 2022). Several studies (Abu-Rabia, 2007; Abu-Rabia & Abu-Rahmoun, 2012; Abu-Rabia et al., 2003; Layes et al., 2017) have examined MA skills in Arabic-speaking children with RD. Abu-Rabia's (2007) study examined the relationship between MA (using a written judgement and production task) and reading among Palestinian Arabic-speaking students with RD in the 3rd, 6th, 9th, and 12th grade. Results showed that MA predicted voweled reading accuracy and reading comprehension across all grade levels. A study examining MA among 11-year-old TD Arabic-speaking students and students with dyslexia in Algeria (Layes et al., 2017) as well as a younger reading-level matched group of 9-year-old TD students showed that the students with dyslexia were weaker than the age-matched control group on the MA tasks (a combination of several oral and written judgement, production, and pattern recognition tasks), but performed similarly to the reading-level matched group (Layes et al., 2017). MA also explained variance in reading comprehension but not voweled reading accuracy. A meta-analysis of studies (Georgiou et al., 2022) including both English and Arabic studies has shown that children with RD perform significantly lower than age-matched controls on MA tasks with a large effect size that is equal to the effect size seen for RAN deficits (Araújo & Faísca, 2019), but lower than the effect size seen for phonological deficits (Melby-Lervåg, 2012). However, when compared with reading-level matched controls, children with RD did not perform lower than controls on MA tasks (Georgiou et al., 2022). Since the children with RD did not perform lower on MA tasks in comparison to the reading-level matched controls, then this suggests a delay in reading development (as opposed to a different pattern of reading development to the age-matched controls). As mentioned in section 2.4.5 and 2.4.6, as TD children gain more exposure to reading, they accumulate more MA and more orthographic representations of words and morphemes (Deacon et al., 2013; Georgiou et al., 2022). Therefore, the reason why Arabic-speaking children with RD's MA skills were weaker than TD children in Abu-Rabia and Abu-Rahmoun's (2012) study was explained to be that since children with RD tend to read less hence their exposure to new words and in turn their storage of morphemes in memory is poorer (Abu-Rabia & Abu-Rahmoun, 2012). This explanation is in line with Georgiou et al.'s (2022) results regarding English-speaking students as well as Layes et al.'s (2017) results showing similar MA in Arabic-speaking children with RD and reading level-matched controls with similar exposure to reading.

A lot of these previous studies have looked at the weaknesses in students with RD while a minority of studies have looked at the strengths (MA) in these students (Casalis et al., 2004; Cavalli et al., 2017; Elbro & Arnbak, 1996). Studies examining English-speaking and Arabic-speaking readers who were TD and poor readers found that MA contributes to reading processes independently of PA in both groups (Abu-Rabia et al., 2003; Nagy et al., 2003). If an individual shows a deficit in one skill and not the other, then this is classified as a dissociation (Crawford et al., 2010). A recent study of French-speaking dyslexic university students showed a dissociation between phonological and morphological abilities (poor phonological, strong morphological), and the degree of dissociation was positively correlated with their reading skills, which may suggest that they are using their morphological skills to compensate for weaknesses in their phonological skills while reading (Cavalli et al., 2017). Elbro and Arnbak (1996) have shown evidence that adolescents with dyslexia who have poor phonological skills are better at decoding words with a transparent morphemic structure (e.g. sunburn) as opposed to words without a transparent morphemic structure (e.g. window) while no difference in word decoding was seen in reading-age matched controls. Furthermore, a study examining Arabic-speaking children with RD in the first to fourth grade whose phonological deficits were relatively worse than their morphological deficits has shown that MA predicted a significant, although small amount of variance, in reading nonwords suggesting that these children might be using their MA skills to read to compensate for their weak PA skills (Saiegh-Haddad & Taha, 2017). Tibi and Kirby (2019) examined 8-year-old children in the UAE and divided the sample into good and poor decoders based on their high and low nonword reading scores. Results indicated that MA explained significant variance in reading accuracy and fluency of voweled words in the poor decoders but not the good decoders (Tibi & Kirby, 2019). The authors argued that the good decoders mainly relied on PA for reading accuracy of voweled words and naming speed for reading fluency of voweled words. This suggests that poor decoders may need to resort to other processing strategies (such as MA) because of their inability to automatically recognize words as well as their weaknesses in phonological decoding. Another study examining 13-year-old Arabic-speaking students with RD in Israel found that they rely on MA to read voweled words, which may be considered a compensatory strategy used in reading due to their weakness in phonological skills (Abu-Rabia & Abu-Rahmoun, 2012). Finally, Bowers et al. (2010) have reviewed 19 intervention studies and most have focused on teaching English oral and written morphology, suffixes and prefixes, and analysing morphemes in complex words. Results showed that the morphological intervention studies were more effective on “less able” children, which included children with dyslexia and poor readers, but these results should be interpreted with caution as they include small sample sizes (Bowers et al., 2010, p. 147). The reason that these students benefited more is not clear but could be attributed to their poor phonological skills and the use of morphology as a compensatory strategy (McCutchen et al., 2014).

The previous studies (Cavalli et al., 2017; Elbro & Arnbak, 1996; Saiegh-Haddad & Taha, 2017) have suggested the hypothesis that students with reading difficulties may use MA while reading to compensate for their phonological deficits. The reason this compensation strategy occurs can be explained by the psycholinguistic grain size theory (Ziegler & Goswami, 2005), mentioned in section 2.3.6, which states that children choose to decode words using linguistic units that depend on the orthographic consistency and availability of those units in oral language. However, since the phonemic unit is an area of weakness for children with RD and is not readily available, then these children may resort to using larger grain sizes such as morphemes to decode words (Kotzer et al., 2021). Further research is needed to examine whether children with RD use MA as a compensatory mechanism while reading. If that is true, then the implication of that would be the inclusion of both phonological and morphological aspects in the design of interventions aimed at students with RD (Reid, 2016), which is an area that will be covered in the discussion section. Additionally, the research reviewed in this section covered monolingual children with RD reading in the English and Arabic orthography. However, research examining bilingual children with RD is scarce (Zhang & Wang, 2023), and it is important to examine whether these children also may use MA as a compensatory strategy while reading. The next section reviews literature related to bilingual children with RD to understand the nature of RD within bilingual children.

2.6.5. Reading difficulties and bilingualism

Students with reading difficulties in one language will usually have problems with reading and writing in an additional language (Dal, 2008; Schneider, 2009; Schneider & Crombie, 2004; Shakory et al., 2023; Sparks & Ganschow, 1993). The central processing hypothesis (Geva & Siegel, 2000), mentioned in section 2.5.2, has also been extended to children with RD where it has been argued that children with deficient cognitive and linguistic skills will face problems in reading regardless of the orthography or type of language script (Bialystok & Ryan, 1985; Geva & Ryan, 1993; McLaughlin et al., 1983). If children have reading difficulties in their L1, then they should also have reading difficulties in their L2 (although note that a case study of a boy aged 16 years showed that he had difficulties reading and writing in English (L1) but not in Japanese (L2) (Wydell & Butterworth, 1999), but the study has been criticized that it did not measure non-word reading in Japanese and may have shown difficulties in Japanese had it measured it (Ziegler & Goswami, 2005).

Extended from the script-dependant hypothesis (Geva & Siegel, 2000), mentioned in section 2.5.2, it has been debated whether the orthography of the language affects the degree of reading difficulties (Gholamain & Geva, 1999). Since the relationship between letters and sounds are different in consistent/inconsistent orthographies, then this may lead to different patterns of reading difficulties in these orthographies (Geva & Siegel, 2000). A study examining bilingual Portuguese-English students with RD (Da Fontoura & Siegel, 1995) and another study examining Arabic-English students with RD (Abu-Rabia & Siegel, 2002) showed that low reading scores were found in both their L1 and L2 supporting the central processing hypothesis (Geva & Siegel, 2000). In both studies, the bilingual students with RD were compared to an English monolingual group of children with RD. The bilinguals with RD showed higher scores on pseudoword reading and phonological tasks when compared to the monolingual children with RD. It was argued in both studies that this pattern of effects was likely due to positive transfer from learning a consistent orthography (Arabic and Portuguese). Another study examined English monolingual adults with dyslexia and compared them to Welsh-English bilingual adults with dyslexia on reading irregular English words and pseudowords (Lallier et al., 2018). Monolinguals with dyslexia were weaker in reading pseudowords than irregular words, and bilinguals with dyslexia were weaker in reading irregular words than pseudowords. Also, monolinguals with dyslexia showed worse phonological processing deficits than bilinguals with dyslexia. Lallier et al. (2018) argue that this is likely due to positive transfer from learning a consistent orthography like Welsh suggesting learning in one language may influence the strategies used in reading another language. Evidence from these three studies show stronger pseudoword reading and phonological skills in bilingual students with reading difficulties, which is likely due to positive transfer from learning a consistent orthography. This supports the script dependant hypothesis (Geva & Siegel, 2000) as well since being exposed to two different orthographies with varying consistency may influence the pattern of reading difficulties due to transfer of skills between the orthographies. Whether children with RD's schooling (monolingual vs bilingual) influences their linguistic and reading skills will be discussed in the next section.

2.6.6. Reading difficulties and bilingual education

It is the norm, in the Middle East, to exempt students with RD from learning a second language, and to focus on developing literacy skills in their native language (Abu-Rabia et al., 2013; Mohamadzadeh et al., 2020). However, a study looking at the effects of an intervention in English (L2) on Arabic-speaking poor readers found that both Arabic (L1) and

English reading and linguistic skills improved because of the intervention (Abu-Rabia et al., 2013). This evidence shows cognitive retroactive transfer (CRT), which is when a student uses cognitive skills that were learned later (L2) to skills that were learned at an earlier time (L1), and is an extension of the linguistic interdependence hypothesis (mentioned in section 2.5.2) in which the opposite direction of transfer (L2 to L1) is also added (Abu-Rabia et al., 2013; Cummins, 1979). Abu-Rabia et al. (2013) argue that children with RD should not be exempt from learning an additional language, and with carefully planned learning goals and effective teaching methods employed in L2, improvements in L1 would also be seen.

Abu-Rabia et al.'s (2013) study has also shown transfer of morphological skills from English to Arabic (L2 to L1) in which the morphological measures included tasks that required identification of roots and stems, derivational tasks, and inflectional tasks. Although the improvement in morphological skills was higher in English than in Arabic, transfer of these skills occurred between languages (L2 to L1) with different levels of morphological complexity. Ramirez et al. (2010) argued that it is easier for morphological skills to transfer from a language that is morphologically complex to a language that is morphologically transparent. Ramirez et al. (2010) suggest this could be because children reading in morphologically complex languages may develop a higher sense of awareness to morphology or that MA could be more related to reading in morphologically complex languages (Geva et al., 1997). However, Abu-Rabia et al. (2013) argue that is not necessarily the case and that basic linguistic skills are common to all orthographies regardless of the orthographic depth and the morphological complexity.

A recent study examined sixth-grade students from schools for children with learning difficulties in Israel (Abu-Rabia & Salfety, 2021). The researchers divided the sample into 90 dyslexic students in the experimental group and 90 dyslexic students in the control group. Reading accuracy, fluency, and comprehension, spelling, morphology, syntactic knowledge, orthographic knowledge, vocabulary, and PA skills were assessed in both English and Arabic. The students were then divided into three groups based on their L1 scores on voweled word reading accuracy. If the students achieved scores of 20% or lower, then they were considered to have severe dyslexia. Scores of 21-40% were considered to have moderate dyslexia, and scores of 41% and above were considered to have mild dyslexia. The experimental group participated in an intervention programme carried out in English (L2) targeting letter-sound knowledge, morphology, orthographic knowledge, vocabulary, grammar, spelling, and reading fluency and comprehension strategies. Results showed that, when compared to the control group who didn't participate in the intervention programme, post-intervention English scores (L2) were significantly better on PA, reading fluency and comprehension, vocabulary, and syntactic knowledge. The improvement in the mild group and moderate group was significantly higher than the improvement in the severe group on all skills examined. The study also examined whether the intervention carried out in English (L2) influenced Arabic (L1) skills. The Arabic post-intervention scores were significantly better than the control group on voweled, unvoweled, nonword reading, and reading comprehension only supporting the CRT theory (Abu-Rabia et al., 2013). The improvement in the mild group was significantly higher than the improvement seen in the moderate and severe group on L1 skills. The difference in the improvement of skills between the mild, moderate, and severe group highlights the heterogeneous nature of children with RD, and that one recommendation does not apply to all students with RD and should be tailored to the specific profile of the child with RD.

A study was conducted to evaluate achievement of students receiving special education accommodations in 90:10 two-way immersion programs in the US compared to students not attending this program (Thomas et al., 2010). A 90:10 two-way immersion program allocates certain times to teach in a certain language. In the 90:10 model, students in kindergarten and the first grade receive 90% of their instruction in the non-English language (Lindholm-Leary, 2004). This percentage then decreases yearly until instruction is divided between both languages equally. Most of the students (90%) were receiving special education accommodations due to specific learning disabilities and specific language impairment (Thomas et al., 2010). The students in the third to sixth grade attending the immersion program achieved higher scores in reading on state assessments than those that were not. It is important to note that the sample size in this study was small, but results support the notion that students with special needs can benefit from attending immersion programs (Genesee & Fortune, 2014; Thomas et al., 2010). A study comparing dyslexic bilingual 10-year old children (Italian as L2, different L1s) to monolingual Italian-speaking dyslexic children showed both groups of children had equivalent PA scores (Vender & Melloni, 2021), equivalent phonological memory scores (Vender et al., 2020), as well as higher scores on an inflectional morphology task in dyslexic bilinguals than dyslexic monolinguals (Vender et al., 2018).

To sum up, very few studies have examined the influence of bilingual education on children with RD, and most of the studies are in the US or Italy and need to be replicated in the Arab population. In addition, studies examining Arabic-speaking students in Israel (which make up a majority of the published research reviewed in this chapter) may not be generalizable to other Arabic-speaking populations as students in Israel begin learning to read in Arabic, then learn to read Hebrew in the second grade, and then begin learning to read English in the third grade (Russak, 2021). This calls for more research to take place in other Arabic-speaking populations who are learning to read and write in Arabic and English simultaneously. It is theoretically interesting to examine this biliterate population, as mentioned earlier, because they are reading in orthographically deep orthographies where morphology is an important factor in both. It is important to examine whether bilingual education influences children with RD in a positive or negative way to better inform parent's decisions. The next section summarizes the aims of the current study based on the gaps highlighted in the reviewed literature.

2.7. The aims of the current study

As discussed, English and Arabic monolingual research has established the importance of PA in English word reading (Ball & Blachman, 1988; Fox & Routh, 1984; Tunmer et al., 1988; Wagner & Torgesen, 1987) and Arabic word reading (Abu-Ahmed et al., 2014; Mannai & Everatt, 2005; Smythe et al., 2008; Taibah & Haynes, 2011). Secondary to that, English and Arabic monolingual research has also highlighted the importance of MA in English word reading (Levesque et al., 2017; Nagy et al., 2006; Singson et al., 2000) and Arabic word reading (Abu-Ahmed et al., 2014; Abu-Rabia, 2007; Asadi et al., 2017; Saiegh-Haddad & Taha, 2017; Tibi, 2016; Tibi & Kirby, 2017, 2018; Tibi et al., 2019). The aim of this thesis is to examine whether the contribution of MA to word reading that was evident among monolingual populations also exists among (Arabic-English) bilingual populations, a question which has been largely unexplored. Within language associations between linguistic skills and reading skills will be examined in each language separately within the bilingual children to understand whether observations made previously on monolingual children apply to bilingual children as well or whether bilingual children show a novel pattern of effects due to being exposed to two different linguistic systems and possible transfer of skills between languages (Cummins, 1978, 1979).

English monolingual research (Snowling, 1980, 2013; Stanovich & Siegel, 1994; Vellutino et al., 2004; Vellutino & Scanlon, 1987; Wagner & Torgesen, 1987) and Arabic monolingual research (Abu-Rabia et al., 2003; Elbeheri & Everatt, 2007; Layes et al., 2015; Mannai & Everatt, 2005; Saiegh-Haddad & Taha, 2017; Smythe et al., 2008) has identified the main cause for word reading difficulties to be deficits in phonological processing. Secondary to that, deficits in MA was also seen English monolingual children with reading difficulties (Carroll & Breadmore, 2018; Elbro, 1990; Tsesmeli & Seymour, 2006) and Arabic monolingual children with reading difficulties (Abu-Rabia, 2007; Abu-Rabia et al., 2003; Layes et al., 2017; Saiegh-Haddad & Taha, 2017). However, the role of morphological deficits in word reading difficulties needs to be explored further as morphology may be used by children while reading to compensate for deficits in phonological processing (Cavalli et al., 2017; Elbro & Arnbak, 1996; Saiegh-Haddad & Taha, 2017). As most of the previous observations were made based on research on monolingual English and Arabic children with RD, there is a clear need for research on bilingual children with RD. Therefore, another aim of this thesis is to explore the contribution of MA to word reading among bilingual (Arabic-English) children with RD on both a single-case basis and a group basis.

Finally, most of the studies discussed showed evidence to support bilingual education over monolingual education, but most were focused on North American samples and include students with various special needs. They need to be replicated in other communities and languages while focusing on children with RD to examine the effectiveness of interventions carried out on students attending a monolingual program compared to a bilingual program. The main concern is whether the intervention should be carried out in L1, L2, or both. This addresses the other aim of this thesis, which is the need to examine the influence of bilingual and monolingual education on linguistic skills and reading skills of children with RD. The thesis will be divided into two separate studies which will be detailed in the next section.

2.7.1. Study 1 research questions

Study one involved a comparison between a group of TD children and a group of children with RD attending bilingual schools in Kuwait. It addresses the following research questions:

1. Are linguistic skills and reading skills compromised in a group of children with RD compared to an age-matched control group, both of which are attending a bilingual school?
2. Is morphological awareness (MA) more strongly related to reading in Arabic than in English?
3.
    a. Is MA associated with reading accuracy and fluency levels over and above the influence of phonological processing within each language? Does the relationship differ depending on the reading task (accuracy/fluency)?
    b. Within reading accuracy and fluency, does the relationship between MA and reading differ depending on the type of word (nonword/regular/exception/voweled/unvoweled) within each language?
    c. Within reading accuracy and fluency, does the relationship between MA and reading differ depending on the type of word (nonword/regular/exception/voweled/unvoweled) within each language in each of the two groups (TD and RD) whilst controlling for phonological processing?
4.
    a. Upon examining the profile of children with RD individually using a case series approach, do they show a deficit in PA, MA, both, or neither in each language? Is there a dissociation between PA and MA?
    b. Is there a relationship between the magnitude of dissociations and reading performance in children with RD, suggesting that they are using their morphological skills to compensate for the weakness in their phonological skills?

2.7.2. Study 2 research questions

The second study involved a comparison between a group of children with RD attending bilingual schools and another group of children with RD attending monolingual schools in Kuwait. It addresses the following research question:

1. Is there a difference in linguistic and reading skills in children with RD who are attending a bilingual school with those attending a monolingual school (is there an advantage for bilingualism in RD children?)

How these groups were sampled, and how and what tasks were used to measure each of the constructs mentioned will be discussed in the next chapter.

3. Methodology

3.1. Introduction

As mentioned in the previous chapter, the aims of this thesis were to explore the contribution of MA to word reading among bilingual (Arabic-English) children with RD on both a single-case basis and a group basis as well as to examine the influence of bilingual and monolingual education on linguistic skills and reading skills of children with RD. By addressing these aims, the thesis plans to contribute new knowledge to the related field of study, and this knowledge has to be defined under different theories of knowledge depending on the position taken in how the world is viewed and knowledge is obtained, which leads to a chosen methodology (Crotty, 1998). To be able to achieve these research aims and answer the questions the research addresses, a process and plan was needed to gather and analyse data, known as research methods (Creswell, 2014). These methods were pre-determined and selected based on the strategy of research design, which is also known as the methodology (Crotty, 1998). This chapter details the research paradigm, the selection of the methodology, the research design, the ethical considerations and approval, the sampling plan and participants recruited, and the reliable and valid research materials and analysis that was used to derive this new knowledge.

3.2. Paradigm rationale

A paradigm is the cumulative set of assumptions about the world and how one researches it, which combines epistemology, ontology, theoretical perspective, methodology, and methods under one umbrella (Denzin & Lincoln, 1994). In the case of this study, it falls under the positivism umbrella. The assumption of epistemology, also known as different theories of knowledge, under this paradigm is objectivism (Crotty, 1998). Objectivism assumes that things exist and have a meaning whether someone is aware of that existence or not and assumes that research can obtain that objective meaning or truth (Crotty, 1998). Ontology defines a researcher's reality, and the ontology assumed under this paradigm is realism, in which the researcher defines reality to exist outside of someone's mind (Crotty, 1998). Objectivism and realism both feed into a theoretical perspective.

A theoretical perspective is the position a researcher chooses according to one's view of the world and how one obtains knowledge (Crotty, 1998). The theoretical perspective assumed in this study is the post-positivist theoretical perspective. Positivism is related to the philosophy of science, which seeks to discover accurate and objective knowledge from objects as opposed to other positions that are more related to subjective opinions and beliefs about objects (Crotty, 1998). Post-positivism challenged positivism by arguing that there is no absolute truth when it comes to studying humans (Phillips & Burbules, 2000). The absolute truth is hard to find, and research produces evidence that is not perfect. Post-positivists use the scientific method which starts with a theory that defines how the researcher carefully measures and observes the objective truth that exists (Phillips & Burbules, 2000). This is done through an experiment with carefully measured variables that are used to test hypotheses. Tools are used to carefully measure and quantify variables. The results are not perfect so experiments are replicated and changes are made to reduce errors to be able to make stronger observations and conclusions (Phillips & Burbules, 2000).

As a result of choosing this paradigm, the research will test theories related to MA, reading, RD, and biliteracy, mentioned in Chapter 2. The selection of an approach is influenced by the nature of the problem (Creswell, 2014). If the problem requires the examination of the relationship between variables, how these variables influence an outcome, or which variable best predicts this outcome, then a quantitative approach is more appropriate (Creswell, 2014). Since the aim of this research is to examine the relationship between MA and reading measures, the extent to which MA predicts these reading measures, and whether schooling influences reading outcomes, then the nature of the problem influenced the selection of this approach. The next section details the research design of the current study.

3.3. Research Design

To infer cause and effect between variables, experimental research designs are used, but the experiment must be designed in a rigorous manner, such as randomized control trials, where subjects are assigned randomly to experimental and control groups (Gopalan et al., 2020). Causality can be inferred because differences in the outcomes of both groups can be credited to the experimental condition rather than other influences. However, in Education, sometimes this design cannot be achieved due to it being expensive, practically unfeasible, and sometimes unethical (Gopalan et al., 2020). Therefore, this leads to the use of experiments that arise from a naturally occurring circumstance, known as quasi-experimental research designs, where the differences in the independent variable may not be induced, but occur naturally, and the groups are not randomly assigned (Gopalan et al., 2020).

The current study employed a quasi-experimental research design where participants were allocated to groups based on naturally occurring circumstances. For example, in Study 1, the naturally occurring circumstance was whether the child had a reading difficulty, forming two groups: TD and RD. In Study 2, the naturally occurring circumstance was schooling, again forming two groups: monolingual and bilingual. This is also known as a convenience sample (Creswell, 2014).

The control group in Study 1 included TD students who were attending bilingual schools. The experimental group included students with RD attending the same bilingual school as the control group. The groups were matched on age. The children in both groups were tested in both Arabic and English. In Study 2, one group included the students with RD attending a monolingual school where most of the instruction takes place in Arabic. The second group was the students with RD attending bilingual schools from Study 1. The two groups were matched on age. The children in both groups were tested in Arabic only. Non-verbal and verbal ability was assessed in both Study 1 and 2 so that any differences between the two groups could be controlled for.

In addition to that, the current study's research design also involved making individual comparisons of each RD student's phonological awareness and morphological awareness scores with the performance of the means of the TD group. A single case methodology was used to analyse the performance of each RD case in two tasks (PA & MA) in both languages in comparison to the control group (Crawford & Garthwaite, 2005a; Crawford et al., 2010), more details about this methodology will be given in section 3.10. The next section details the ethical considerations of the current study and procedures followed to obtain ethics approval and consent.

3.4. Ethical considerations and consent

Research must follow an ethical code of conduct to ensure that the research team knows what to do and what not to do (Cohen et al., 2017). Ethics committees reviewing the research advise the research team on ethical issues based on laws, regulations, and documents relating to ethical issues in research. A document prepared by The United Nations relating to working with children specifically and especially those diagnosed with difficulties was very relevant to this study (Graham et al., 2013). Some of the points outlined in this document include having respect for the child, partaking in research that is in interest of the child, protecting the child from harm, respecting the privacy and confidentiality of the child, and making sure the child is volunteering to take part in the study by providing informed consent. Informed consent is when the child chooses to take part in the study once the child has been told about the study and what is required of him/her (Diener & Crandall, 1978). The research must also be fair to children and not discriminate between children especially those diagnosed with disabilities (Graham et al., 2013). The research must use instruments that are not biased to certain abilities, a race, or culture (Knauss, 2001). It is important to make sure that instruments used for testing and the results of the tests are used fairly, and that the uses of the test has been checked to include usage for research purposes, known as consequential validity (Cohen et al., 2017).

This project has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct, see ethics approval in Appendix 1. Signed consent was sought from principals of schools involved and participants' parents, see information sheets and consent forms in Appendix 1. Children were informed of the study and asked to verbally assent, see student information sheet in Appendix 1. Participants' and the research team's responsibilities were clearly stated on the information sheets as well as the purpose of the study, participants' rights, how their data will be protected, who will have access to the data, and how it will be stored. As outlined in the information sheets, data collected was anonymised and the identity of participants and schools was treated confidentially. Children were offered breaks between tasks, reassured that they can withdraw without any consequences, and that the research team only had access to their answers which was used for the current research project only and was completely unrelated to their schoolwork. The next section details the participants recruited for the current study.

3.5. Participants

3.5.1. Study 1

Study 1 compared children with and without dyslexia, all of whom attended bilingual schools. Given the complexity of the education system and the key differences between different types of schools in Kuwait, it was imperative that children in the participant groups were recruited from equivalent schools. Children in the control group were sampled from two private bilingual schools that contain inclusion classes recognized by the government. These schools have been reviewed by the government to follow standard criteria for LD provision (mentioned in section 1.2.), and therefore Kuwaiti citizens attending these schools who have a LD can apply for financial support. The children were tested from the targeted fourth and fifth grades (ages 9 to 11). As mentioned in section 2.4.6, children are exposed to unvoweled script starting from around the third grade (Mahfoudhi et al., 2010). This age group was targeted because they have had one to two years of experience reading this type of unvoweled script, and it is likely that they have developed sufficient phonological and morphological skills to be able to complete the tests. Initially, data was planned to be collected from approximately 30 children in the control group (TD) and 30 children in the experimental group (RD). This sample size was selected based on a power analysis run on the ‘Power and Precision’ software package recommended by Field (2018) assuming statistical power of 0.8 and an alpha level of 0.05 and using a two-tailed significance test, which are values recommended by Cohen (1988a). However, the plan was changed to recruit as many TD children as possible. The rationale behind that decision was since the research design involved making single-case comparisons of each child with RD against the performance of the TD group, then a bigger sample size would be better as this group would be considered a normative sample. Therefore, this resulted in recruiting a total of 41 TD children. Children were excluded from testing if their school or teacher reported any significant behavioural, reading, or learning problems. The goal was to recruit an equal number of males and females to mirror the distribution in the population (Mahfoudhi et al., 2010). Additional information about the child’s past language exposure was verified and measured using a parental questionnaire, detailed in the next section. This provided more information about whether children in these schools may be considered simultaneous bilinguals, which was defined as children exposed to two different languages from birth, or sequential bilinguals, defined as children who are exposed to a second language at age three onwards (Paradis et al., 2011), as mentioned in section 2.5.

Children in the experimental group (RD) were sampled from the same two private bilingual schools as the control group. Data was collected from 19 children in the experimental group (RD). This number is lower than planned, and limitations relating to small sample sizes will be addressed in Chapters 4 and 5. The children with a dyslexia diagnosis or an LD diagnosis from a certified assessment centre in Kuwait were candidates for this sample. These diagnostic reports were reviewed, and children were excluded from the study if the nature of their learning difficulty was not related to word-reading. According to the practices of the Centre where children were diagnosed, these children were diagnosed as having dyslexia based on having typically developed intelligence (IQ above 85) and significant deficits on their scores on achievement tests in literacy in English and Arabic, or were diagnosed as having LD based on having typically developed intelligence (IQ above 85) and significant deficits on their scores on achievement tests in literacy in English, Arabic, and mathematics skills. Additional information about their language exposure was also collected in the parental questionnaire.

3.5.2. Study 2

Study 2 involved a comparison between children with reading difficulties attending bilingual versus monolingual schools. Children in the monolingual group were sampled from a private school, sponsored by the government, for children with LD where most of the school instruction takes place in Arabic. Data was collected from 21 children in the monolingual group. This school follows the public-school curriculum except that teaching methods are adapted to cater to children with LD and class sizes are smaller. These children are then reintegrated into the public-school system as soon as considered suitable. The children had all been diagnosed with dyslexia or LD by the same certified assessment centre in Kuwait. The children were diagnosed with dyslexia or LD based on the same criteria as the bilingual group (except they had not been assessed in English). The same exclusion procedure for RD children was followed as in Study 1. Although these children learn English in the second grade, they were considered monolingual following the same rationale as in Tibi & Kirby's (2017) study in the UAE, which is similar to Kuwait in that both UAE and Kuwait are Gulf Arab countries that share similar public school curriculums as well as cultural and educational links (Saiegh-Haddad & Everatt, 2017). The rationale for considering these children as monolinguals relates to factors such as the majority language of instruction the child learns in, the language in the community, and the age of exposure to the language, which defines a child's level of bilingualism (Paradis et al., 2011; Tibi & Kirby, 2017). Looking at the majority Arabic language instruction in the school, these students' level of English is considered very elementary. Also, these children have limited exposure to English outside the class and in the home (this was confirmed upon the completion of the parental questionnaire). The student's classmates are mostly Kuwaiti students in the public-school system, as mentioned in section 1.2., and so they mostly communicate with them in Arabic. Therefore, the children were considered monolingual. This monolingual group was compared to the same bilingual group from Study 1, which includes children with RD attending bilingual schools.

To sum up, in Study 1, both TD and RD groups were recruited from the same private bilingual schools that contain inclusion classes. Two bilingual schools with inclusion classes signed consent forms to participate in the current study. The schools' administrations provided an estimate of the average percentage of instructional hours allocated to English

(65%) as a medium of instruction as opposed to Arabic (35%) in the academic year. In Study 2, the monolingual group was recruited from a private monolingual school specialized for LD students. Another monolingual school consented to participate in the current study. However, none of the parents consented for their children to participate.

3.6. Materials and measures

The first aim of this research (Study 1) was to examine the relationship between MA and word-level reading (accuracy and fluency) controlling for phonological processing. Therefore, instruments measuring phonological processing, MA, and reading accuracy and fluency in Arabic and English are detailed below. Measures of control variables such as non-verbal ability, receptive vocabulary, socio-economic status (SES), and past language exposure will also be detailed below. Some measures were obtained using standardized tests. However, since there is a lack of available equivalent standardized tests in Arabic, some measures were borrowed and adapted from previous research for the purpose of this study. These measures have been previously used in published research. Additional morphological tasks that were adapted for the current study were also piloted on a small group of students before their use in the current study, details of the pilot study will be provided in this section as well. All tasks included three to four examples where the child practiced what was required, it was made sure that the child understood the task, and feedback was given when the child gave an incorrect response to explain the task further. For the Arabic tasks, all instructions were given in the Kuwaiti dialect. For English tasks, all instructions were given in English. The next sections detail the tasks administered.

3.6.1. Reading measures

3.6.1.1. Reading Accuracy

A standardized measure of reading accuracy in English was obtained using the Diagnostic Test of Word Reading Processes (DTWRP) (Forum for Research in Literacy and Language, 2012). This test required the child to read three sets of 30 letter strings as accurately as they can. The first set is comprised of regular words (e.g. sun), the second set is comprised of non-words (e.g. keet), and the last set is comprised of exception words (e.g. ghost).

Equivalent tasks in Arabic have been developed and used in Saiegh-Haddad & Taha's (2017) study, which required children to read three sets of 30 words as accurately as possible. The first set comprised voweled words ranging from 3 to 10 phonemes, 2 to 7 letters, and 1 to

2 morphemes. Vowelization included only phonemic diacritics (short vowels, consonantal gemination, and null vocalization). The second set was comprised of unvoweled words that are comparable to the voweled words (in number of phonemes, letters, and morphemes) and five judges ranked their familiarity, following which analyses showed that there was no significant difference in familiarity between the two sets of words. The third set comprised a list of comparable nonwords (in number of phonemes, letters, and morphemes) that are voweled using phonemic diacritics only. The word items are provided in Appendix 2. Reading accuracy was measured as the number of correct responses out of the total number of words. This task needed approximately 10 minutes to be administered for each language.

3.6.1.2. Reading Fluency

A measure of reading fluency in English was obtained using the standardized Test of Word Reading Efficiency in English (TOWRE-2) (Torgesen et al., 1999). The children were required to read a list of words and a list of non-words. The task involved reading as many items on the list (accurately) as possible within 45 seconds. An equivalent task in Arabic was obtained using a list of words from the word reading test that was developed and used in Tibi’s (2016) study. The list of words was edited to eliminate the grammatical diacritics and nunation from the ends of the words. The reason that was done was to make this task in line with the reading accuracy task, mentioned in the section above, which included phonemic diacritics only. Since grammatical diacritics do not change the meaning of the word, then eliminating them was thought to help the students read words faster as this task was a reading fluency task. The list comprised voweled words ranging from 1 to 5 morphemes (Tibi et al., 2020), and are included in Appendix 3. Reading fluency was calculated as the number of words read accurately in the first 45 seconds of testing as done in the TOWRE-2 and in previous work in the literature (Schiff & Saiegh-Haddad, 2017). The list of non-words was obtained from the Children's Standardized Phonological Processing Test (Taibah et al., 2011). The list of non-words was also edited to eliminate the grammatical diacritics and nunation from the ends of the words. This task took approximately 2 minutes for each language.

3.6.2. Linguistic measures

3.6.2.1. Phonological Processing

Three phonological processing measures were administered in this study that have been used frequently in previous work in the literature examining reading and reading difficulties in both English and Arabic (Elbeheri & Everatt, 2007; Smythe et al., 2008). The English instrument was the standardized elision subtest from the Comprehensive Test of

Phonological Processing (CTOPP) (Wagner et al., 1999), which required the child to delete certain sounds from words. For example, say “cup” without saying /k/, and the child was required to say the response “up.” This subtest measured the child’s awareness of sounds and one’s ability to manipulate sounds of words, which is a skill related to phonological awareness (Wagner et al., 1999). Therefore, this subtest was used to measure phonological awareness in this study. An equivalent standardized elision subtest in Arabic was administered from the Children's Standardized Phonological Processing Test (Taibah et al., 2011). For example, the child was required to say the word (بسا تين) without saying / بسا/ and the child was required to say the response (تين) .

The second standardized subtest that was administered was the rapid letter naming subtest in English (Wagner et al., 1999). This subtest required the child to name aloud 36 letters organized into 4 rows of 9 letters as fast as they can measuring the fluency of matching the letters with their phonological labels (the 36 letters were comprised of 6 recurring letters: a, c, k, n, s, t) (Wagner et al., 1999). This task was originally a standalone task designed by Denckla & Rudel (1974), but the version included in the CTOPP was used to measure RAN in English in this study. The task was comprised of two trials (naming aloud the 36 letters twice) and the score was the time in seconds it took to name all the letters in both trials. An equivalent standardized task was administered in Arabic obtained from the Children's Standardized Phonological Processing Test (Taibah et al., 2011). The task required the child to name aloud 36 letters organized into 4 rows of 9 letters twice as fast as they can. However, the letters were 12 recurring letters written in the following format: (ب , ك , ز , م , ي , ل , ن ه, ع , ط , س , و). Both tasks took approximately 5-10 minutes for each language.

The third task administered in English was the non-word repetition subtest of the CTOPP (Wagner et al., 1999). The child was required to listen to a recording of non-words and was asked to repeat the non-words accurately. The total score was the number of non-words that were repeated accurately. As mentioned in section 2.2.2, phonological memory is usually measured using non-word repetitions tasks because the phonological information of these non-words would be accessed from the short-term memory as only real words are stored in the long-term memory (Gathercole & Baddeley, 1990). An equivalent standardized task was administered in Arabic from the Children's Standardized Phonological Processing Test (Taibah et al., 2011). Both tasks took approximately 3 minutes for each language.

3.6.2.2. Morphological awareness

3.6.2.2.1. Pre-pilot Morphological Awareness

Two tasks were used to measure derivational morphological awareness, but each of the tasks were presented in the oral modality and the written modality resulting in a total of four tasks. A morphological awareness index was calculated by averaging the z scores on the four morphological tasks as done previously in the literature (Gilbert et al., 2013). Although the tasks presented in the written modality are considered morpho-orthographic tasks, the morphological awareness index refers to both tasks administered in the oral and written modality as done in Saiegh-Haddad & Taha's (2017) study. All four tasks focused on assessing derivational morphology skills only and did not include inflectional morphology skills. The rationale behind focusing on derivational as opposed to inflectional morphology was because of the unique derivational structure in Arabic, see section 2.4.3. All four tasks took a total of approximately 10 minutes for each language. All test items are available in Appendix 4 except for the adapted Arabic oral and written analogy tasks, which include missing items from standardized tests that cannot be shared due to copyright issues, see signed copyright document provided in the ethics form in Appendix 1.

The first task was a judgement task known as the morphological relatedness task, which is a task used frequently in the literature when attempting to measure morphological awareness (Mahony et al., 2000; Nagy et al., 2003; Nagy et al., 2006). The task was adapted from Nagy et al.'s (2006) study where the child was required to identify whether a word is derived from a second word. As in Nagy et al.'s (2003) study, the task was shortened and adapted to include high-frequency words only. This was done because, in the case of this study sample where English is the second language, only high-frequency words were suitable. Twenty word-pairs were presented to the child half of which were presented visually while the examiner read the word-pairs to the child while the remaining half were presented orally. It was important to read the word-pairs to the child to measure the child's ability to identify morphological relationships as opposed to the ability to decode words. The score was the total correctly identified word items. For example, the child had to indicate whether the word 'teacher' comes from the word 'teach' in which case the correct response would be yes whereas whether the word 'corner' comes from the word 'corn' where the correct response would be no (corner contains a pseudo-morpheme where the added letters are not a morpheme). The tasks in both languages include 10 word-pairs that are morphologically related and 10 word-pairs that are not (containing pseudo-morphemes in English). An equivalent task was administered in Arabic that was borrowed from Saiegh-Haddad & Taha's (2017) study. Twenty word-pairs were presented (half visually and half orally), and the child was required to identify whether the words in the pairs were derived from the same root. The word pairs that were not derived from the same root share similar meanings. For example, مُصوّر - صورة (photographer-photograph) share the same root while مُهَرّج-سيرك (clown-circus) do not. Test items can be found in the Appendix 4.

The second task was a production task, known as a word-analogy task, adapted from several previous studies, detailed below. The child was required to produce a missing word based on a pattern. For example, the examiner said 'walk' followed by 'walker' and then said 'teach' and the child was required to produce the word 'teacher', both oral and written responses were accepted as was done in the literature (Mahfoudhi et al., 2012). It was important to include phonological changes so that the child does not use phonological skills only to produce the word but uses morphological skills as well (Kirby et al., 2012). An example of a phonological change is warm : warmth :: strong : strength. If the child uses his/her phonological skills only, then the child would produce the incorrect answer 'strongth.' The task included both 8 real word items and 8 non-word items to be administered using oral modality. For example, the child was presented with written real-word items such as 'sad' and 'sadness' followed by the non-word 'prist' where the child is required to produce the non-word 'pristness'. The use of non-words in this task is to ensure the child performs the task using his/her knowledge of deriving words correctly as opposed to being familiar with deriving a real word (Mahfoudhi et al., 2010). Of the English items that were included in the task, eight of the real word items were taken from Kirby et al.'s (2012) analogy task, seven non-word items were taken from James et al.'s (2020) analogy task, and one non-word item was taken from Caroll and Breadmore's (2018) dynamic morphological awareness task, which can be found in Appendix 4. The score was the number of correct words produced. A similar production task was also administered in the written modality which included 8 real word items and 8 non-word items where the examiner would read the test items for the student to make sure all items were decoded accurately. Of the items included, two real word items were included from Kirby et al.'s (2012) analogy task, five of the real word items were included from James et al.'s (2020) analogy task, one real word item was included from Mahoney et al.'s (2000) word relations task, 6 non-word items were included from Caroll and Breadmore's (2018) dynamic morphological awareness task, and two non-word items were included from James et al.'s (2020) analogy task, which can be seen in the Appendix 4.

An equivalent task in Arabic was designed by Tibi (2016) based on the task used in Kirby et al.'s (2012) and Nunes et al.'s (1997) studies. The task originally contained 11 inflectional items and nine derivational items. Only eight of the derivational items from this task were used where one included a phonological change and all included nonlinear transformations, shown in Appendix 4. For example, the student was required to complete the following analogy where the correct answer would be (صابِرْ), رَقَصَ : راقِصْ :: صَبَرَ:. Eight non-word items were added to the task to match the real word/non-word combination of items that were administered in English. For example, the student was required to complete the analogy where the correct answer would be (مَعْصَقْ), نظر: مَنْظر:: عصق ::. Five of these items were adapted by combining items from a real word production subtest and a non-word production subtest to produce the analogy item. These subtests were from Mahfoudhi et al.'s (2012) Children's Standardized Orthographic Processing and Morphological Awareness Test (CSOPMAT). An additional three items used combinations from the non-word production subtest only, and real-word items were added to match the analogy, see items provided in Appendix 4 where items from the standardized test were omitted due to copyright issues. A similar production task was also administered in the written modality, which included 8 real word analogies and 8 nonword analogies. An example of the real word analogy would be a real root was presented in written format 'ك ت ب' (a root shared by all words related to 'write') followed by a derived real word 'مكتبة' (library) which is derived using the place adverbial word-pattern (maCCaCa), see section 2.4.3. The two preceding items represent the real word analogy. This is then followed by a real root such as 'د ر س' (a root shared by all words related to 'study') where the child was required to produce the word 'مدرسة' (school) using the same place adverbial word-pattern (maCCaCa). Another example of the non-word analogy was when a real root was presented in written format 'ك ت ب' (a root shared by all words related to 'write') followed by a derived real word 'مكتوب' (written) which is derived using the passive adjective word-pattern (maCCu:C), see section 2.4.3. The two preceding items represent the real word analogy. This is then followed by a pseudo-root such as ' ف خ ج' where the child was required to produce the pseudo-word 'مفخوج' using the same passive adjective word-pattern (maCCu:C). Of the non-word items included, six of the analogies were combined using items from the real word production subtest and nonword production subtest of the CSOPMAT (Mahfoudhi et al., 2012). The two remaining non-word items were created by using non-word roots and word patterns from the non-word production subtest of the CSOPMAT (Mahfoudhi et al., 2012) where they were matched with real roots and words. The real word items included a combination of real word analogies that were created, real word analogies created to match with real word items from the real word production subtest of the CSOPMAT (Mahfoudhi et al., 2012), or real roots from the real word production subtest of the CSOPMAT (Mahfoudhi et al., 2012) combined with word-patterns that were created, see examples in Appendix 4, bearing in mind omitted items from the standardized test due to copyright issues. All of the items in the task employed word-patterns that are familiar and taught regularly in Arabic classes (Mahfoudhi et al., 2010). Since Arabic word-patterns are consistent, the task was able to assess whether the child was able to grasp derivational morphological awareness in Arabic or not, and to ultimately examine whether this skill is related to single-word reading accuracy and fluency. Each item was read aloud by the examiner and both oral and written responses were accepted as a correct response (Mahfoudhi et al., 2012). The four morphological awareness tasks were piloted on a small group of students where consent from parents to participate in the pilot study was obtained. Results of the pilot study are detailed in the next section.

3.6.2.2.2. Pilot study results and changes

The morphological awareness tasks mentioned in the previous section were piloted in two phases. In the first phase, the tasks were piloted on a group of five TD students (4 females, 1 male) ranging in age from 9-10 years old. Average age in months was 117 (*SD* = 5.1). Two more students were also included one of whom was an eight-year-old female, and the other was a 10-year-old male diagnosed with Attention Deficit and Hyperactivity Disorder (ADHD). Results from phase I are reported in Tables 1 and 2 below. Means, standard deviations, and errors on items were analysed and changes were made on the tasks to improve task sensitivity, as outlined below.

For the English judgement tasks, changes were made to the tasks by removing the easy items and adding more difficult items from Nagy et al.'s (2006) study. The word pairs that were not related weren't necessarily pseudo-morphemes (e.g. corn/corner), but some items started with the same sounds (e.g. mention/men), see Appendix 5 for task items. For the English analogy tasks, items were changed to 10 items instead of 16 as the task was taking longer to administer than planned. The items that were too easy and too difficult were removed from the analogy task that was presented in the oral modality ending up with five real word items from Kirby et al.'s (2012) analogy task, four non-word items from James et al.'s (2020) analogy task, and one non-word item from Caroll and Breadmore's (2018) dynamic morphological awareness task, which can be found in the Appendix 5. As for the task presented in the written modality, similar changes were made ending up with four real word items from James et al.'s (2020) analogy task, one real word item from Mahoney et al.'s (2000) word relations task, and five non-word items from Caroll and Breadmore's (2018) dynamic morphological awareness task, which can be seen in Appendix 5.

As for the Arabic tasks, no changes were made to the judgement tasks. The Arabic analogy tasks were also decreased to 10 items and the items that were too difficult or too easy were removed. The analogy tasks presented in the oral modality ended up including five real-word items from Tibi's (2016) standard word analogy task and five non- word items. Three of these non-word items were adapted by combining items from a real word production subtest and a non-word production subtest to produce the analogy item from the CSOPMAT (Mahfoudhi et al., 2012). An additional two items used combinations from the non-word production subtest only, and real-word items were added to match the analogy, see items provided in Appendix 5 where items from the standardized test were omitted due to copyright issues. Finally, similar changes were made to the written analogy task, which ended up including five non-word items, four of which were combined using items from the real word production subtest and nonword production subtest of the CSOPMAT (Mahfoudhi et al., 2012). The remaining non-word item was created by using non-word roots and word patterns from the non-word production subtest of the CSOPMAT (Mahfoudhi et al., 2012) where they were matched with real roots and words. The real word items included a combination of real word analogies that were created, real word analogies created to match with real word items from the real word production subtest of the CSOPMAT (Mahfoudhi et al., 2012), or real roots from the real word production subtest of the CSOPMAT (Mahfoudhi et al., 2012) combined with word-patterns created, see examples in Appendix 5 bearing in mind omitted items from the standardized test due to copyright issues.

The four new morphological awareness tasks were then piloted again in phase II on a group of seven children with RD (4 males, 3 females) ranging in age from 8-11 years old. Average age in months was 126 (*SD* = 16.04). This was done to make sure that not only TD students were able to complete these tasks. Results from phase II are reported in Tables 1 and 2 below. Means and standard deviations were analysed, and it was concluded that RD students were able to complete the tasks and these tasks were then used in Study 1 and 2 of the current study. Reliability estimates for the four tasks should have been calculated at this stage. Reliability estimates were calculated after the completion of data collection, and issues related to this topic are tackled and resolved in the next chapter.

Table 1. Mean scores and standard deviation of the English piloted morphological tasks

Task	Phase I (n = 7)		Phase II (n = 7)	
	M	*SD*	*M*	*SD*
Judgement oral	8.71	0.76	8.43	1.99
Judgement written	9.29	0.49	7.43	2.64
Analogy oral	9.00	3.92	4.86	3.08
Analogy written	13.00	1.63	6.14	3.13

Note. Phase I includes TD children and one child with ADHD, Phase II includes children with RD. Mean raw scores are reported out of 10 items for judgement tasks and out of 16 items for analogy tasks in Phase I. Raw scores out of 10 items for all tasks in Phase II.

Table 2. Mean scores and standard deviation of the Arabic piloted morphological tasks

Task	Phase I (n = 7)		Phase II (n = 7)	
	M	*SD*	*M*	*SD*
Judgement oral	9.14	1.07	7.14	1.35
Judgement written	8.86	1.46	7.14	2.87
Analogy oral	7.29	5.35	2.71	2.14
Analogy written	11.29	5.53	3.71	3.40

Note. Phase I includes TD children and one child with ADHD, Phase II includes children with RD. Mean raw scores are reported out of 10 items for judgement tasks and out of 16 items for analogy tasks in Phase I. Raw scores out of 10 items for all tasks in Phase II.

3.6.3. Control measures

Control variables are measured because they are also known to influence the outcome variable (reading ability) and need to be controlled for making it easier to identify the actual influence of the independent variable alone (Creswell, 2014). Therefore, since the current study aimed to examine associations between MA and reading beyond phonological processing, additional measures were controlled for so that the association between MA and reading is not due to other variables. In this case, the control variables were nonverbal ability, receptive vocabulary, SES, and past language exposure. Research has shown that vocabulary influences word reading (Cunningham & Stanovich, 1990) so it needs to be controlled for and vocabulary is also associated with MA tasks, especially production tasks (Mahony et al., 2000; Singson et al., 2000). It is also important to measure non-verbal ability because it has been argued to measure the ability to tackle new tasks, which is related to a student's ability to tackle new PA, MA, and reading tasks (Deacon et al., 2007). In addition to that, it was important to measure non-verbal ability, particularly because non-verbal ability tasks assess the student's ability to analyse patterns and analogies in matrices, which may be related to MA tasks that include analogy tasks (Deacon et al., 2007). Previous research has suggested that non-verbal ability influences literacy in Arabic-Speaking students (Abu-Rabia et al., 2003; Mannai & Everatt, 2005) and may have a larger role when reading Arabic text than English text (Everatt et al., 2000). It has also been reported that children with RD may use their non-verbal skills to compensate for weaknesses in their language skills (Snowling, 2000). Non-verbal ability and verbal ability (for which vocabulary is a proxy) measure a student's general ability, which is important to control for as it is usually related to reading (Deacon et al., 2007). SES was also measured to control for any differences between the samples as children raised in lower SES environments may perform poorer on reading measures than children raised in higher SES environments (Yando et al., 1979). These effects have also been observed in Arabic-speaking children in Israel (Arafat et al., 2017; Saiegh-Haddad et al., 2020). Since language exposure influences language development in bilingual children in areas such as morphology (Paradis, 2010), then it also needs to be controlled for.

3.6.3.1. Non-verbal ability

As mentioned in the previous section, non-verbal ability was measured to control for differences between the sample groups. Due to time constraints, a full intelligence assessment was not possible, so non-verbal ability was assessed. To measure non-verbal skills, the adapted computerized version of Ravens Progressive Matrices was used, which is a standardized measure of non-verbal ability, that has been normed on a Kuwaiti population (Abdulraoof, 2009). The test consists of 20 different patterns presented in a sequence where the child was required to complete the missing pattern in the sequence by selecting one from a set of six to eight choices. All the patterns consisted of visual geometric designs with a missing piece. This test took approximately five minutes.

3.6.3.2. Receptive vocabulary

Receptive vocabulary was measured in Arabic using a translated version of the Peabody Picture Vocabulary Test—Revised (PPVT-R) (Dunn & Dunn, 1981) that has been normed on the Kuwaiti population (Abu-Allam & Hadi, 1998). Receptive vocabulary was measured in English using The British Picture Vocabulary Scale (BPVS III) (Dunn et al., 1997). The receptive vocabulary measure took approximately 10 minutes for each language.

3.6.3.3. Past language exposure

Information was collected from parents about the children's past exposure to Arabic and English using the Bilingual Language Exposure Questionnaire (Unsworth, 2013). This questionnaire is usually administered face to face or by telephone, but it was possible to create an online version based on the paper-based version. An online version of the questionnaire was created, using Redcap software, based on the paper-based version to be filled out at the parent's convenience, see Appendix 6 for English and Arabic versions created. It took around 5-10 minutes for the parent to complete the questionnaire. Parents had the option of filling out the questionnaire in English or Arabic. The questionnaire's translation was done according to back-translation, which is a common method used in cross-cultural research where a bilingual from the research team translated the questionnaire from English to Arabic and a third party translated the questionnaire back to English (Cohen et al., 2017). The two English versions were checked to make sure the meanings have not changed to ensure that the Arabic version of the questionnaire was considered acceptable.

This questionnaire allowed the calculation of the child's exposure to English and Arabic over time, known as cumulative language exposure (Unsworth, 2013). This measure was developed by Unsworth (2013) because previous measures focused on current language exposure, and, in her view, looking at exposure over time helps to make comparisons between bilinguals and monolinguals more accurate. Information was collected about how much language exposure the child has had to English and Arabic in preschool, school, activities done in out-of-school hours, at home, and in the holidays for each year of the child's life from birth up until the third grade (age 8 to 9). A 5-point Likert scale was used to approximate language exposure in each scenario in the questionnaire. The scale is as follows:

- 0% = hardly ever English, almost always Arabic
- 25% = seldom English, usually Arabic
- 50% = 50% English, 50% Arabic
- 75% = usually English, seldom Arabic

- 100% = almost always English, hardly ever Arabic

This resulted in an approximate estimate of the child's language exposure in the past based on data reported by parents. Parental report is considered valid as it is easier for parents to report behaviour about their children than about their own behaviour (Paradis et al., 2010).

Certain measures need to be calculated to arrive at the cumulative language exposure calculation. The amount of exposure to the language in the home was averaged between the parents, any other adults living in the home (if any), and siblings (if any) weighted equally. Time spent in pre-school, school, activities spent out-of-school hours for each year of the child's life was calculated using average school hours (5 hours for ages 4-6, 7 hours for ages 6 and up) and average holidays in Kuwait (6 weeks). Average number of waking hours per year are estimates provided by Unsworth (2013) based on the average number of hours that children spend sleeping. A calculation was done, known as the proportion of the year spent at pre-school (P_{PS}), school (P_S), out-of-school (P_{OS}), home (P_H), and holidays (P_{HOL}), which was calculated as time spent at pre-school/school/out-of-school/home/holidays divided by average number of waking hours per year. Finally, the language exposure (LE) was calculated by multiplying the proportion of the year spent at pre-school/school/out-of-school/home/holidays by the language exposure provided by parents at pre-school (LE_{PS}), school (LE_S), out-of-school (LE_{OS}), home (LE_H), and holidays (LE_{HOL}) for each year. The cumulative language exposure (*CLE*) is the sum of the language exposure for each year as seen in (1).

$$CLE = \sum LE = (P_{PS}\ x\ LE_{PS}) + (P_S\ x\ LE_S) + (P_{OS}\ x\ LE_{OS}) + (P_H\ x\ LE_H) + (P_{HOL}\ x\ LE_{HOL}) \qquad (1)$$

3.6.3.4. Socio-economic status

Additional questions relating to parental education and occupation were included in the questionnaire to calculate SES by averaging both parents' level of education score as in Vender et al.'s (2018) study. A score of one point was awarded for primary education (elementary/middle school), two points for secondary education (high school), three points for higher education (Bachelor's degree), and four points for postgraduate education (Master's/PhD degree). The next section details the procedure in which all the above materials and measures were administered.

3.7. Procedure

Redcap software was used to distribute online information sheets and consent forms to parents in both English and Arabic. Parents provided e-consent by adding their name, signature, date, and ticking checkboxes. After obtaining consent from schools and parents, parents were contacted to schedule test sessions at their convenience. Due to restrictions related to COVID-19, the tests and tasks were administered virtually, using university-approved video conferencing software, because access to children in schools was not permitted. All safety measures relating to COVID-19 enforced by the government/school were followed meticulously. At the beginning of the testing session, the student information sheet was shown to the child to obtain verbal consent before administering the tasks. All assessments were audio recorded to ensure the accuracy of the scoring. It was ensured that the child and parent had turned off their video before the session was audio recorded, letting them know the instant in which the recording had started. All tests were administered individually by the researcher. Assessments took place in English and Arabic for the bilingual students in the control (TD) and experimental group (RD) in Study 1. The children were tested in English on one day and in Arabic on another day within the same week. Since the participants were being repetitively exposed to the assessment materials in the two languages, the order of the English/Arabic days were counterbalanced as well as the order of the tasks administered. This was done to make sure that the order of the tests did not influence the student's performance (Allen, 2017). Counterbalancing is a procedure whereby the order of the conditions of a study is changed to improve the internal validity of the study and to randomize measurement error (Allen, 2017). Each session was approximately 60-80 minutes each. The children were given frequent short breaks when necessary. Assessments took place in Arabic only for the monolingual group in Study 2, which took approximately 60-80 minutes. Additional sessions were scheduled, if needed, in the case where the student was not able to complete all the tasks required. Parents were contacted through text message or email at the contact details they have provided in the consent forms and were asked to fill out the online questionnaire. All tests and questionnaires were safely stored, scored, and reliable and valid data was ready to be analysed, which will be detailed in the next section.

3.8. Valid findings

Whether a piece of research is valid is important (Cohen et al., 2017). In quantitative research, validity is enhanced when the sampling procedure is carefully considered, the instruments used to measure the variables are suitable, and the statistical methods used to analyse the relationship between those variables are fitting. All statistical methods are not fully valid and have a built-in measure of error that must be considered.

There are two ways in which the validity of quantitative research can be threatened: internally and externally (Creswell, 2014). Internal validity is threatened when factors threaten the research design and the ability to draw conclusions about the outcomes of the study (Cohen et al., 2017). For example, as time passes in an experiment, external factors can influence the outcome of an experiment. Therefore, it must be ensured that participants in the control and experimental groups are exposed to the same external factors. Also, as time passes during the experiment, the participants become older; therefore, having age-matched groups in the sample ensures participants are becoming older at the same rate. The participants in the current study were exposed to similar external factors and were age-matched across experimental and control groups to ensure that internal validity was not threatened. As mentioned on section 3.7, counterbalancing was done to improve the internal validity of the study (Allen, 2017). External validity relates to the generalizability of the results to different settings, samples, and participants. For example, if the sample has specific characteristics, and the experiment takes place in a specific setting and time, then to generalize results of an experiment it should be replicated on groups with several characteristics, several different settings, and over different time periods.

Construct validity refers to whether the instruments used measure an abstract concept derived from theory, such as MA, and whether the instrument fairly measures the construct and only the construct (Cohen et al., 2017). Certain techniques such as factor analysis can be used to measure whether the instrument is measuring a construct by grouping together certain items and separating them from other unrelated items (Cohen et al., 2017). As discussed in section 2.2.2.3, different tasks are used to measure MA depending on various factors such as whether the task is oral or written, whether the task focuses on derivational or inflectional morphology, and whether the task assesses implicit or explicit knowledge (Deacon et al., 2008). Several studies (Goodwin et al., 2017; Kieffer & Lesaux, 2012a; Tibi & Kirby, 2017) have examined these different MA tasks in English and Arabic using factor analysis and have validated MA as a construct that falls under one dimension. Tibi and Kirby’s (2017) study also showed the predictive validity of these tasks, meaning that these tasks predicted a significant amount of variance in Arabic reading. Since the current study employs similar tasks used in previous research in both English and Arabic (oral-written, judgement-production), then these tasks are considered valid in measuring MA as a construct in both languages. It is also important to test for MA in more than one way which was done in the current study, as recommended in Apel et al.'s (2013) study, to increase the validity of measuring a construct like MA and to make the findings more robust and generalisable (Shadish et al., 2002). The use of non-word stimuli in the MA tasks in the current study also helped to separate the contribution of vocabulary and MA to reading (James et al., 2020).

3.9. Reliability

Reliability in quantitative research is a measure of stability, and measures how consistent the results of a research instrument are over time and over different samples (Cohen et al., 2017). To ensure rigour in this study, reliable tests and instruments were used, and reliability was measured for each instrument to measure internal consistency of the items. The Cronbach alpha, which measures the correlation between each item in the test, was measured for tasks which required administration of all items. Split-half reliability was measured for tasks with a termination rule splitting the odd and even questions (Cohen et al., 2017). All reliability estimates are reported in the next chapter. The MA tasks were piloted on a small group of children to ensure that the test items were not too difficult and not too easy. The instructions for all the instruments were also standardized to control the conditions in the data collection process.

3.10. Data Analysis

The aim was to have a study with high statistical power to ensure that the study has a high probability of finding an effect in the population and avoid type I and II errors (false negatives or positives) (Field, 2018). A rigorous level of significance (the probability that the statistical models fit the data well) were used (Field, 2018). The initial plan was to use between-group parametric tests to analyse data from both Study 1 and 2. However, because the assumptions of the parametric tests were violated (discussed further in Chapter 4) then non-parametric tests were used for the group analyses.

One of the aims of the current study involved making individual comparisons between each RD student's PA and MA (in both languages) scores and the performance of the means of the TD group using a single case methodology (Crawford & Garthwaite, 2005a; Crawford et al., 2010). In neuropsychology studies where single-case methodologies are utilised, usually a case's score on a test is converted to a *z* score using a control sample's mean and standard deviation. That *z* score is then assessed using tables of the area under the normal curve to determine whether the score is significantly different from the control sample (Ley, 1972). Crawford & Howell (1998) argue that, with control samples that are small in size ($n < 50$), a more robust method is to use a modified *t*-test (Sokal & Rohlf, 1995) to compare a case's scores to a control sample and assume that the individual case is equivalent to $n = 1$. This method uses the t distribution instead of the normal distribution with n-1 degrees of freedom to test whether the case's scores are significantly lower than that of the control sample. The method employs the following equation to calculate *t* as seen in (2) where X is the case's score, $\overline{X}$ is the mean of the control sample, S is the standard deviation of the control sample, and n is the size of the control sample.

$$t = \frac{X - \overline{X}}{S\sqrt{\frac{n+1}{n}}} \tag{2}$$

Crawford & Garthwaite (2005b) have run simulations to compare the two methods and results showed that the modified *t*-test would significantly reduce the Type 1 error rate (where a case is said to be impaired on a task when it is not) in comparison to the method of using *z* scores. They have also run simulations on control samples that are negatively skewed and advise that a *p* value of .025 (one-tailed) should be used. Results showed that even in control samples with high levels of skewness, when this reduced *p* value is used, then, in 95% of cases, that score would not come from the control population. Crawford & Howell's (1998) test uses a one-tailed test because the null hypothesis is being tested against a one-directional hypothesis of whether the case shows an impairment in the task and would perform worse than the controls.

The purpose of this study aim was to examine if a case is impaired in one task e.g. (phonological awareness) and less impaired or not impaired in a second task (morphological awareness). When a case shows impairment in one set of skills (X) and doesn't show impairment in a second set of skills (Y), then this is defined as a classical dissociation (Ellis & Young, 1996; Shallice, 1988). In contrast, if a case shows impairment on both skills (X & Y) but is much more impaired in X than Y, then this is defined as a strong dissociation (Shallice, 1988). Crawford & Garthwaite (2005b) argue that the above definition of having a dissociation is not robust enough because single-case studies usually have low power because they compare one case (as opposed to a group of cases) to a control sample that is usually small in size. The authors also argue that a case may be just below the arbitrary cut-off point on task X and just above it for task Y and be falsely defined as having a dissociation. Therefore, Crawford & Garthwaite (2005b) developed a new method called the revised standardized difference test (RSDT), which tests whether the standardized differences between tasks X and Y is statistically different from the distribution of differences in the control sample, see Appendix 7 for detailed calculations and equation. The authors have added a new criterion to the definition “classical dissociation” in which not only does the case show impairment in X and not Y, but the standardized difference in scores between the two tasks X and Y are significantly different when compared to the distribution of the standardized differences between tasks X and Y in the controls. For “strong dissociation”, the case must be impaired in *both* X and Y and show significant standardized differences between X and Y when compared to the distribution of standardized differences in the control sample. Crawford & Garthwaite (2005b) ran simulations on the RSDT compared with other previous methods to test for significant differences between scores on X and Y, and results showed that the RSDT has lower Type 1 error percentages (where a case is said to have a dissociation when it does not) than other previous methods. The authors advise using a p value of lower than 0.025 (two-tailed) when both tasks X and Y are skewed. Detailed results are reported in the next chapter.

A useful dataset of phonological processing, MA, and word reading in bilingual (Arabic-English) children with and without RD was established. New knowledge was derived by using single-case methods to analyse whether children with RD may be using MA skills to compensate for weak PA skills. To address the remaining aims of the current study, classic group analyses were used to derive new knowledge related to whether theories of MA and word reading developed on monolingual children apply to bilingual children or not. Finally, new knowledge was derived by comparing the influence of monolingual and bilingual education on children with RD’s linguistic and word reading skills in Arabic. This dataset was inputted into SPSS, analysed, and several inferential statistical analyses were performed to be able to address the aims of the study, detailed in the next chapter.

4. Results

4.1. Introduction

This chapter is split into two sections, Study 1 and Study 2, where the first examined children with and without RD, all of whom were attending a bilingual school, while the second examined children with RD who attended either a bilingual school or a monolingual school. Each section will present information about the demographics of the participants including age, grade, and gender. In addition, information about the participants' SES and detailed analysis of their reported language exposure in the past is presented. This is also followed by presenting descriptive statistics on the control, independent, and dependent variables of the study along with reliability measures. The chapter also reports detailed analyses to address the research questions of the study.

4.2. Study 1

4.2.1. Demographics of participants

This study included 53 participants who were grouped between TD children and children with RD all of whom were attending a bilingual school. The participants were sampled from two private bilingual schools that contain inclusion classes recognized by the government. The participants were recruited from the targeted fourth and fifth grades (ages 9 to 11) to form both a RD group and an age-matched TD control group. The TD children and RD children were recruited. Parents of children with RD provided a Dyslexia diagnosis or an LD diagnosis from a certified assessment centre in Kuwait. This resulted in 34 participants in the TD group, the control group, and 19 participants in the RD group, the experimental group. Most of the children (79%) spoke the Kuwaiti dialect at home in the TD group while the remaining minority were a mix of speakers of Jordanian, Egyptian, and Palestinian dialects. All the children in the RD group spoke the Kuwaiti dialect. All testing took place in English and Standard Arabic.

Following data screening (see next section), one participant was excluded from the RD group and from the study as the nature of her learning difficulty was not related to word-reading. Another participant was moved from the TD group to the RD group based on the criteria that any case scoring below 1.5 SD on word reading and nonword reading in both English and Arabic in the TD group would be moved to the RD group. The cut-off score that was set is supported by the *Diagnostic and Statistical Manual of Mental Disorders*, 5th Ed. (American Psychiatric Association, 2013), and used in recent research (Smail et al., 2022). Six participants were excluded from the TD group and from the study because they didn't meet the inclusion criteria (scoring within 1.5 SD of mean on word reading and nonword reading in either English or Arabic), which was established to ensure that the control group had levels of word reading within the typical range in both languages. Table 3 below summarizes the age, grade, and gender breakdown of the final participants in both the TD and RD groups. Chi square tests indicated that there was no significant association between group and gender $\chi 2(1, N = 53) = 0.004$, $p = .95$, group and grade $\chi 2(1, N = 53) = 0.31$, $p = .58$, and group and age $\chi 2(2, N = 53) = 3.67$, $p = .16$.

Table 3. Frequency of age, grade, and gender of participants in the TD and RD Groups

Group	Age			Grade		Gender	
	9	*10*	*11*	*4*	*5*	*Female*	*Male*
TD Group (n = 34)	15 (44.0%)	13 (38.0%)	6 (18.0%)	17 (50.0%)	17 (50.0%)	14 (41.0%)	20 (59.0%)
RD Group (n = 19)	4 (21.0%)	8 (42.0%)	7 (37.0%)	8 (42.0%)	11 (58.0%)	8 (42.0%)	11 (58.0%)
Total (N = 53)	19 (36.0%)	21 (40.0%)	13 (24.0%)	25 (47.0%)	28 (53.0%)	22 (41.5%)	31 (58.5%)

Note. TD refers to typically developing children and RD refers to children with reading difficulties. Average age in months for the TD group is 122 months (*SD* = 8.3) and for the RD group is 126 months (*SD* = 9.6).

4.2.2. Data Screening

Data were checked for normality using histograms, *z* scores of skewness and kurtosis, and the Shapiro-Wilk test. This revealed that control variables such as cumulative language exposure (CLE) to English and Arabic, receptive vocabulary (English), non-verbal ability, socio-economic status (SES), were normally distributed. However, receptive vocabulary (Arabic) was not normally distributed. To use parametric tests, one assumption is that the data should be normally distributed (Field, 2018). Also, to use parametric tests, homogeneity of variance needs to be tested to ensure there is no difference in variance between two groups (Field, 2018). Using Levene's test to assess for homogeneity of variance, the control variables showed no significant difference in variance between the TD and RD groups except for receptive vocabulary (Arabic).

The English reading accuracy composite (the average of *z* scores on the three reading measures: nonword reading, exception word reading, and regular word reading) and the reading fluency composite (average of the *z* scores on the two reading fluency measures: nonword reading fluency and real word reading fluency) were normally distributed for both groups. Using Levene's test to assess for homogeneity of variance, the reading accuracy scores showed a significant difference in variance for TD and RD groups while reading fluency did not.

As for the English linguistic skills, which include phonological processing and MA, PA was normally distributed for the RD group but not the TD group. RAN scores were normally distributed for the TD group but not the RD group. Phonological memory scores were normally distributed. The MA composite score (average of *z* scores on the two morphological tasks: judgement and analogy) was normally distributed for the RD group but not the TD group. Using Levene's test to assess for homogeneity of variance, PA, RAN, and MA scores showed a significant difference in variance for the TD and RD groups while phonological memory scores did not. The above data screening measures are summarized and reported in Appendix 8.

Looking at the Arabic measures, reading accuracy was not normally distributed for either group while reading fluency was normally distributed for the TD group and not the RD group, presumably due to the floor effects seen in the RD group for nonword reading fluency, shown in Figure 5 below. PA was normally distributed, and phonological memory was normally distributed for the RD group but not the TD group. RAN was normally distributed for both groups. MA was normally distributed for the RD group and not normally distributed for the TD group, probably due to the ceiling effects shown in Figure 6 below for the judgement scores. Using Levene's test to assess for homogeneity of variance, reading accuracy and fluency, PA, and morphological scores showed a significant difference in variance for the TD and RD groups while phonological memory and RAN did not.

Normality issues could not be resolved by transforming the data because scores were negatively skewed for some variables for the TD group but not the RD group. If a transformation had been done, then it could have resolved the skew in the TD group but would have created skew in the RD group. Therefore, as the assumptions for using parametric tests were violated, non-parametric tests were used in the analyses to address the research questions of this study.

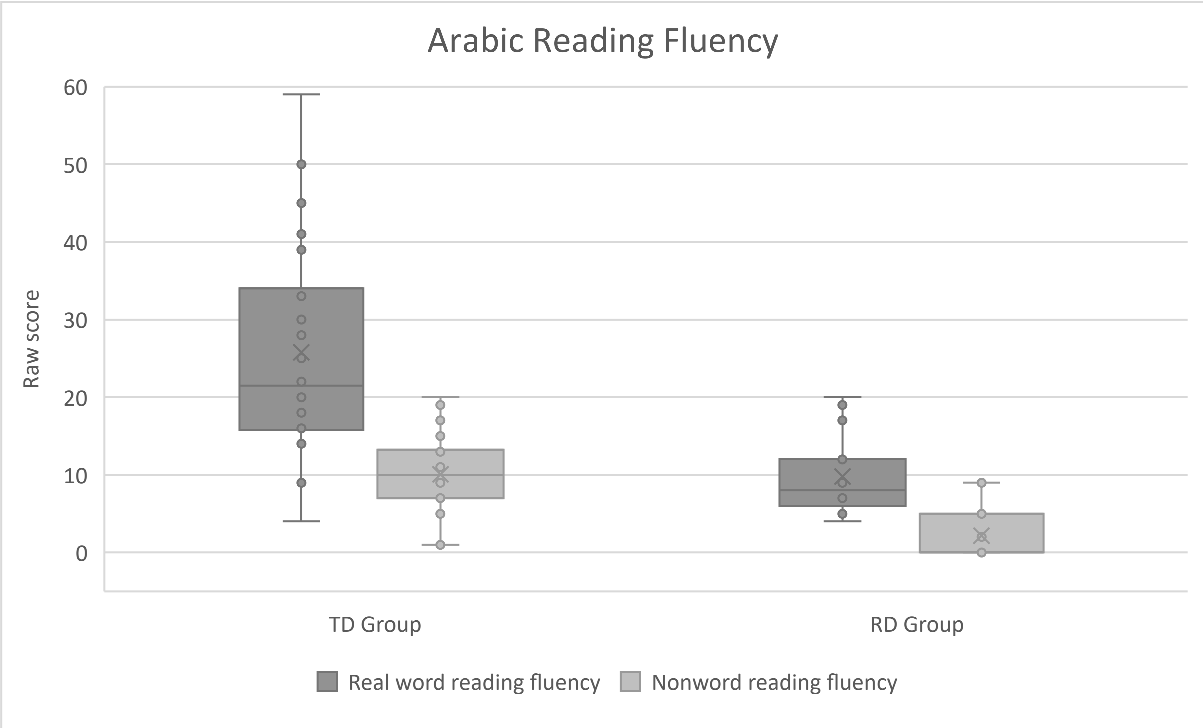

Figure 5. Box plot for Arabic reading fluency in the TD and RD groups

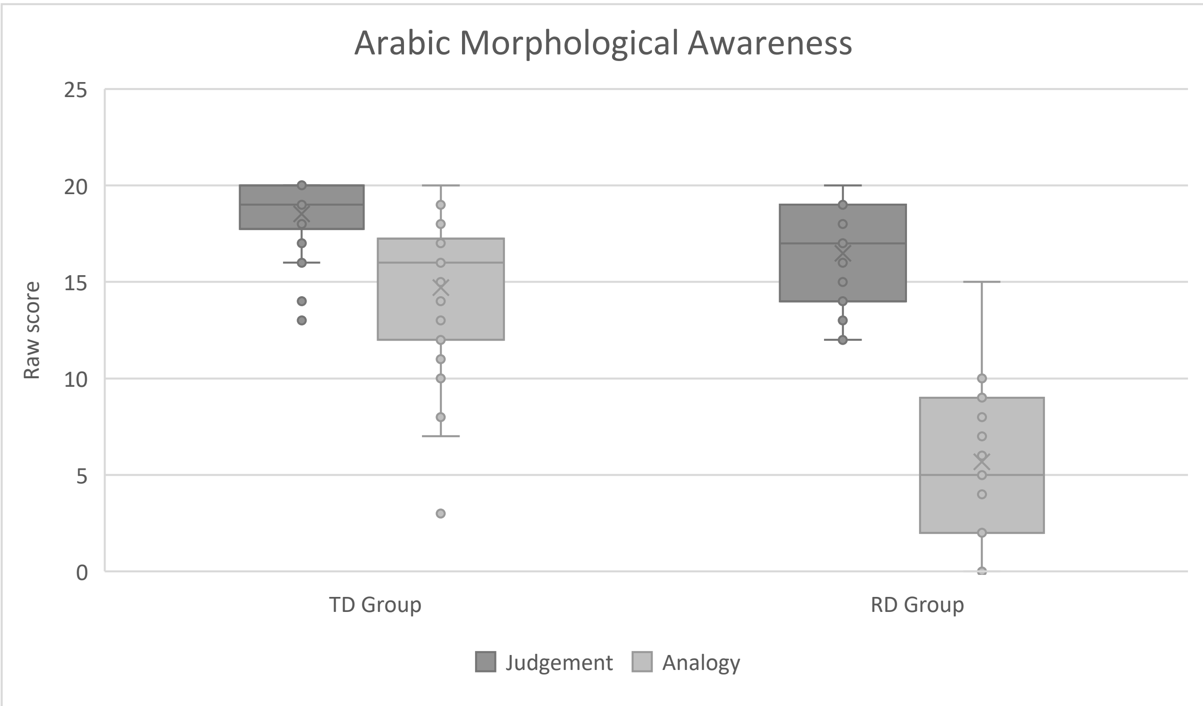

Figure 6. Box plot for Arabic morphological scores in the TD and RD groups

4.2.3. Control Variables

It is important to ensure that the control variables showed no significant differences between the two groups because when these variables are controlled for, then it becomes easier to identify the actual influence of independent variables alone on the dependent variables (Creswell, 2014). This section reports the descriptive statistics of the control variables as well as the results of the non-parametric tests assessing whether there was any significant difference in the control variables between the two groups. The control variables were cumulative language exposure (CLE) to English and Arabic, receptive vocabulary (English and Arabic), non-verbal ability, and socio-economic status (SES).

4.2.3.1. Language Exposure

Information about the child's past language exposure was measured in the Bilingual Language Exposure Questionnaire (Unsworth, 2013), which was filled out by parents online. Mothers filled out the majority (90%) of the questionnaires in both the TD and RD groups with the remaining 10% being a mix of father and grandmother. The questionnaire asked parents to provide information to ascertain whether children in these schools could be considered simultaneous bilinguals or sequential bilinguals (Paradis et al., 2011). Results showed that in the TD Group, 29 participants (85.0%) were simultaneous bilinguals, and five participants (15.0%) were sequential bilinguals. In the RD group, 16 participants were simultaneous bilinguals (84.0%) while 3 participants (16.0%) were sequential bilinguals. Chi square tests indicated that there was no significant association between group and type of bilingualism $\chi 2(1, N = 53) = 0.01$, $p = .92$.

Table 4 below summarizes the mean CLE scores and standard deviation for the TD and RD groups. Non-parametric independent samples tests (Mann-Whitney test) indicated the TD group *(Mdn = 4.08)* and RD Group *(Mdn = 4.47)* did not differ for their scores on CLE to English, $U = 313.50$, $z = -0.18$, $p = .86$, $r = -0.02$. The same test was also carried out for scores on CLE to Arabic indicating no differences in scores between the TD group *(Mdn = 4.93)* and RD group *(Mdn = 4.53)*, $U = 313.50$, $z = -0.18$, $p = .86$, $r = -0.02$.

Table 4. Mean scores and standard deviation of the Bilingual Language Exposure Questionnaire

Measure	TD Group (n = 34)		RD Group (n = 19)	
	M	*SD*	*M*	*SD*
CLE to English	4.22	1.53	4.36	1.95
CLE to Arabic	4.78	1.53	4.64	1.95

Note. TD refers to typically developing children, RD refers to children with reading difficulties, and CLE refers to cumulative language exposure. CLE is the sum of the reported language exposure for each year of the child's life with a maximum value of 9 as it was measured up to age 9.

4.2.3.2 Nonverbal ability, Receptive vocabulary, and SES

Table 5 below summarizes the mean and standard deviation of the control variables: nonverbal ability, receptive vocabulary, and socioeconomic status (SES) for the TD and RD groups. Reliability measures are also reported in Table 5. For nonverbal ability, Cronbach's alpha was calculated since participants were required to respond to all the questions. The reported estimate was calculated using scores of all the participants (N = 74, including the monolinguals from Study 2). As for the receptive vocabulary measures, since there was a termination rule, split-half reliability was measured splitting the odd and even questions. For receptive vocabulary (English), split-half reliability was calculated from the scores of the participants in Study 1 (N = 53) while for receptive vocabulary (Arabic), split-half reliability was calculated using the scores of all the participants (N = 74, including the monolinguals from Study 2.

Table 5. Mean scores and standard deviation of the control variables

Measure	TD Group (n = 34)		RD Group (n = 19)		
	M	*SD*	*M*	*SD*	*r*
Nonverbal ability[1]	63.82	21.68	61.32	25.21	0.70
Receptive Vocabulary (English)[2]	93.18	18.44	78.26	21.59	0.96
Receptive Vocabulary (Arabic)[3]	44.00	29.67	28.26	17.68	0.98
Socioeconomic Status[4]	3.03	0.44	2.95	0.40	

Note. TD refers to typically developing children and RD refers to children with reading difficulties. Scores on nonverbal ability are standardized percentile scores, vocabulary tasks are raw scores, scores for SES are reported scores from the questionnaire: a score of 1 = primary education (elementary/middle school), 2 = secondary education (high school), 3 = higher education (Bachelor's degree), and 4 = postgraduate education (Master's/PhD degree). Reliability estimates for nonverbal ability was calculated using Cronbach's alpha and split-half reliability was used for receptive vocabulary measures.
[1] measured using Ravens Progressive Matrices out of 20 items
[2] measured using The British Picture Vocabulary Scale (BPVS)
[3] measured using Peabody Picture Vocabulary Test—Revised (PPVT-R)
[4] calculated as the average of both parents' level of education score

Table 6 below summarizes the results of the non-parametric tests assessing whether there was any significant difference in the control variables between the two groups. There were no significant differences between the scores on the control variables between the TD and RD group except for receptive vocabulary (English) which showed that the RD group had significantly smaller English vocabulary than the TD group. Although the scores on receptive vocabulary (Arabic) were not significantly different between the two groups, it is worth mentioning that the effect size for the between-group difference in scores was almost the same as for receptive vocabulary (English).

Table 6. Results of Mann-Whitney U to Identify Differences between RD and TD Groups on Control measures; r is also reported as a measure of effect size.

Measure	TD	RD	*U*	*Z*	*p*	*r*
	Mdn	*Mdn*				
Nonverbal Ability	70.00	70.00	310.50	-0.23	.82	-0.03
Receptive Vocabulary (English)	94.50	80.00	196.00	-2.36	.02	-0.32
Receptive Vocabulary (Arabic)	40.00	24.00	226.50	-1.79	.07	-0.25
Socioeconomic Status	3.00	3.00	297.50	-0.51	.61	-0.07

Note. TD refers to typically developing children (n = 34) and RD refers to children with reading difficulties (n = 19).

4.2.4. Results for research question 1.

Are linguistic skills and reading skills compromised in children with reading difficulties compared to the age-matched controls both of which are attending a bilingual school?

Table 7 shows the means and standard deviations of all scores on English reading and linguistic tasks administered to TD children and children with RD all of whom were attending bilingual schools**.** Reliability estimates are also reported for all the English tasks administered. The reliability estimates were calculated from participants' scores in Study 1 (N = 53). The reliability estimates for the reading fluency task was calculated by correlating the two measures real word reading fluency and nonword reading fluency. The reported reliability estimate for the rapid letter naming task was obtained from the CTOPP manual (Wagner et al., 1999). All the reliability estimates for all the English tasks were found to be above the recommended cut-off point of $\alpha = 0.7$ except for the morphological judgement task (Field, 2018). The reliability estimates for the judgement oral task (10 items) and judgement written task (10 items) in English were found to be below the recommended cut-off point of 0.7. Therefore, the raw score for judgement oral was summed with the raw score of judgement written to create a combined score for the judgement task (total 20 items). The combined scores for the judgement task resulted in a split-half reliability estimate that was an acceptable value of 0.7. The analogy written (10 items) and the analogy oral (10 items) tasks were also combined in the same way as the judgment scores resulting in a combined analogy task score (20 items). Both the combined judgment and analogy scores were converted into *z* scores, which were used to calculate the English morphological awareness composite score (the mean of the *z* scores). The combined raw scores for the judgement and analogy tasks as well as the composite score are reported below in Table 7. The split-half reliability estimates for the judgement oral task (10 items) and judgement written task (10 items) in Arabic were also found to be below the recommended cut-off point of 0.7 and were also combined in the same way resulting in an acceptable reliability estimate (reported in Table 9). The analogy scores in Arabic were also combined in the same way and converted into *z* scores. The *z* scores for judgement and analogy were also used to calculate the Arabic morphological awareness composite score (the mean of the *z* scores) also reported in Table 9.

Table 7. Summary of descriptive statistics on all English tasks (N = 53)

Measure	TD Group (n = 34)		RD Group (n = 19)		Reliability estimates
	M	*SD*	*M*	*SD*	
Nonword Reading Accuracy[1]	21.00	5.33	10.16	6.66	0.94
Exception Word Reading[1]	22.82	3.21	15.42	7.46	0.94
Regular Word Reading[1]	25.24	3.64	15.00	7.46	0.94
Reading Accuracy Composite	0.48	0.49	-0.85	0.95	
Real word reading fluency[2]	66.53	9.69	45.37	17.61	0.81*
Nonword reading fluency[2]	36.91	10.94	15.47	12.02	0.81*
Reading Fluency Composite	0.48	0.60	-0.86	0.85	
Phonological awareness[3]	18.21	1.68	10.16	5.46	0.93
Rapid Automatized Naming[4]	40.97	9.28	62.11	34.34	0.85**
Phonological Memory[5]	12.85	2.31	10.58	1.64	0.72
Judgement task[6]	16.24	3.11	14.42	3.41	0.70
Analogy task[6]	15.18	2.07	10.26	4.05	0.82
Morphological Awareness Composite	0.33	0.62	-0.60	0.93	

Note. Scores on all tasks are raw scores except for reading accuracy, reading fluency, and morphological awareness which are composite scores calculated by averaging z scores of several tasks. TD refers to typically developing children and RD refers to children with reading difficulties.

[1] measured using Subtests from Diagnostic Test of Word Reading Processes (DTWRP) out of 30 items

[2] measured using Test of Word Reading Efficiency in English (TOWRE)
[3] measured using Elision subtest from the Comprehensive Test of Phonological Processing (CTOPP) out of 20 items
[4] measured using rapid letter naming subtest from CTOPP
[5] measured using nonword repetition subtest from CTOPP out of 18 items
[6] measured using adapted tasks to measure morphological awareness out of 20 items.
*($p < 0.001$) reliability was calculated by correlating the measures nonword and real word reading fluency using Spearman's rho correlations
**internal consistency reliability coefficient reported in Comprehensive Test of Phonological Processing (CTOPP) manual

A non-parametric independent samples test (Mann-Whitney test) was used to determine if there were significant differences between groups on these measures. Statistically significant between-group differences were found on all English linguistic and reading scores as seen in Table 8 indicating that these skills are compromised in children with RD compared to the age-matched controls (TD). The between group differences on all the English linguistic and reading scores show differences with large effect sizes (Cohen, 1988b).

Table 8. Results of Mann-Whitney U tests to Identify Differences between TD (n = 34) and RD (n = 19) Groups on English measures

Measure	TD	RD	*U*	*Z*	*p*	*r*
	Mdn	*Mdn*				
Reading Accuracy Composite	.60	-.84	61.00	-4.86	<.001	-0.67
Reading Fluency Composite	.51	-1.15	66.00	-4.77	<.001	-0.66
Phonological Awareness	19.00	10.00	42.50	-5.26	<.001	-0.72
Rapid Automatized Naming	42.00	49.00	160.50	-3.02	.003	-0.41
Phonological Memory	13.00	11.00	128.00	-3.66	<.001	-0.50
Morphological Awareness Composite	0.42	-0.24	119.50	-3.77	<.001	-0.52

Note. TD refers to typically developing children and RD refers to children with reading difficulties. Scores on all tasks are raw scores except for reading accuracy, reading fluency, and morphological knowledge which are composite scores calculated by averaging z scores of several tasks.

Table 9 shows the means and standard deviations of scores on all Arabic tasks administered to TD children and children with RD all of whom were attending a bilingual school. Reliability estimates are also reported in Table 9. The reliability estimates were calculated from participants' scores in Studies 1 and 2 (N = 74). The reliability estimates for the reading fluency task was calculated by correlating the real word fluency and nonword reading fluency measures. The reported reliability estimate for the rapid letter naming task was obtained from the Children's Standardized Phonological Processing Test manual (Taibah et al., 2011). All the reliability estimates for all the tasks were found to be above the recommended cut-off point of 0.7 (Field, 2018).

Table 9. Summary of descriptive statistics on all Arabic tasks (N = 53)

Measure	TD Group (n = 34)		RD Group (n = 19)		Reliability estimates
	M	*SD*	*M*	*SD*	
Nonword Reading Accuracy[1]	21.76	6.40	6.79	7.26	0.97
Unvoweled Word Reading[1]	25.91	3.64	10.74	8.77	0.95
Voweled Word Reading[1]	23.76	5.59	9.05	8.07	0.95
Reading Accuracy Composite	.55	.50	-1.00	0.76	
Real word reading fluency[2]	25.79	12.94	9.79	4.95	0.86*
Nonword reading fluency[3]	10.09	4.51	2.16	3.11	0.86*
Reading Fluency Composite	0.47	0.81	-0.84	0.45	
Phonological awareness[4]	15.12	2.24	9.37	3.73	0.89
Rapid Automatized Naming[5]	38.00	14.57	47.74	21.40	0.94**
Phonological Memory[6]	12.68	3.81	8.21	3.39	0.82
Judgement task[7]	18.53	1.76	16.47	2.57	0.70
Analogy task[7]	14.71	3.91	5.68	4.04	0.92
Morphological Awareness Composite	0.44	0.56	-0.78	0.81	

Note. Scores on all tasks are raw scores except for reading accuracy, reading fluency, and morphological awareness which are composite scores calculated by averaging z scores of several tasks. TD refers to typically developing children and RD refers to children with reading difficulties.

[1] measured using reading tasks developed and used in Saiegh-Haddad & Taha’s (2017) study out of 30 items

[2] measured using list of real words obtained from Tibi (2016)

[3] measured using list of nonwords obtained from the Nonword Reading Accuracy subtest from the Children's Standardized Phonological Processing Test (Arabic).
[4] measured using Elision subtest from the subtest from the Children's Standardized Phonological Processing Test (Arabic) out of 20 items
[5] measured using rapid letter naming subtest from the Children's Standardized Phonological Processing Test (Arabic)
[6] measured using nonword repetition subtest from the nonword repetition subtest from the Children's Standardized Phonological Processing Test (Arabic) out of 20 items
[7] measured using adapted tasks to measure morphological awareness out of 20 items
*($p < 0.001$) reliability was calculated by correlating the measures nonword and real word reading fluency using Spearman rho's correlations
** Cronbach's alpha reported in the Children's Standardized Phonological Processing Test manual

To identify differences between RD and TD Groups on Arabic measures, a non-parametric independent samples test (Mann-Whitney test) was used. Most Arabic linguistic and reading scores showed statistically significant differences between the two groups as seen in Table 10 indicating that these skills are compromised in RD children compared to the age-matched controls (TD). However, scores on RAN were not significantly different.

Table 10. Results of Mann-Whitney U to Identify Differences between TD (n = 34) and RD (n = 19) on Arabic measures

Measure	TD	RD	*U*	*Z*	*p*	*r*
	Mdn	*Mdn*				
Reading Accuracy Composite	0.70	-1.13	33.00	-5.38	<.001	-0.74
Reading Fluency Composite	0.36	-1.03	51.50	-5.04	<.001	-0.69
Phonological Awareness	15.00	10.00	46.50	-5.16	<.001	-0.71
Rapid Automatized Naming	37.00	41.00	234.00	-1.65	.09	-0.23
Phonological Memory	14.00	9.00	124.50	-3.69	<.001	-0.51
Morphological Awareness Composite	0.65	-0.72	69.50	-4.70	<.001	-0.65

Note. TD refers to typically developing children and RD refers to children with reading difficulties. Scores on all tasks are raw scores except for reading accuracy, reading fluency, and morphological knowledge which are composite scores calculated by averaging z scores of several tasks.

4.2.5. Results for research question 2.

Is morphological awareness (MA) more strongly related to reading in Arabic than in English?

A non-parametric correlation analysis was used to identify whether MA and reading (accuracy and fluency) were significantly associated in each language. This analysis was first run on the entire sample of children attending bilingual schools (N = 53). Tables 11 and 12 show Spearman's rho correlations between English and Arabic variables, respectively. The correlations indicate that MA was highly correlated with both reading accuracy and fluency in English and the same was observed for Arabic, with the magnitude of correlations between MA and reading appearing somewhat higher for Arabic than English[1]. When these correlation coefficients are squared, this indicates the shared variance between the variables (Field, 2018). For example, MA shares 40% of the variability in reading accuracy while 60% of the variance remains unexplained. The next section will assess whether this shared variance changes when other variables are controlled for such as phonological processing and receptive vocabulary.

[1] Unfortunately, it was not possible to carry out a statistical test of the difference in the magnitude of correlations involving Arabic and English as a nonparametric version of this test is not available.

Table 11. Bivariate Correlations for English Variables (N = 53)

Variable	1	2	3	4	5	6	7
1. Reading Accuracy Composite	—	.88**	.62**	.43**	0.65**	-.64**	.57**
2. Reading Fluency Composite		—	.53**	0.37**	.62**	-.77**	.49**
3. Morphological Awareness Composite			—	.66**	.51**	-.35**	.55**
4. Receptive Vocabulary				—	.24	-.21	.37**
5. Phonological Awareness					—	-.44**	.45**
6. RAN						—	-.30*
7. Phonological Memory							—

*$p < .05$. **$p < .01$.

Table 12. Bivariate Correlations for Arabic Variables (N = 53)

Variable	1	2	3	4	5	6	7
1. Reading Accuracy Composite	—	.89**	.73**	.47**	.81**	-.38**	.48**
2. Reading Fluency Composite		—	.69**	.50**	.73**	-.46**	.46**
3. Morphological Awareness Composite			—	.50**	.63**	-.35*	.50**
4. Receptive Vocabulary				—	.42**	-.27	.38**
5. Phonological Awareness					—	-.30*	.55**
6. RAN						—	-.15
7. Phonological Memory							—

$^{*}p < .05$. $^{**}p < .01$.

4.2.6. Results for research question 3a.

Is morphological awareness (MA) associated with reading accuracy and fluency levels over and above that of phonological processing within each language? Does the relationship differ depending on the reading task (accuracy/fluency)?

A non-parametric partial correlations analysis was carried out to determine whether MA and reading were associated whilst controlling for phonological processing. This analysis was carried out on the whole sample (N = 53) and reading accuracy and fluency composite scores were used. Since there was a difference in receptive vocabulary scores (English) between the TD and RD groups, receptive vocabulary was controlled for as well. There was no association between MA and English reading accuracy ($r(47) = 0.21$, $p = .15$) nor between MA and English reading fluency whilst controlling for phonological processing and receptive vocabulary ($r(47) = 0.10$, $p = .49$) in the entire sample of children attending bilingual schools. However, there was an association between MA and Arabic reading accuracy ($r(47) = 0.42$, $p = .003$) as well as Arabic reading fluency ($r(47) = 0.34$, $p = .02$) whilst controlling for phonological processing and receptive vocabulary. These findings may indicate that PA mediates the relationship between MA and reading in English but not in Arabic where MA continues to correlate with reading even when PA is controlled for. However, the sample was not large enough to support a mediation analysis, so the previous statement is speculative. This analysis provided a general picture of the relationship between MA and reading accuracy and fluency in the entire sample of bilinguals. The next section will assess the relationship between MA and reading based on word type to find out in more detail whether the relationship between MA and reading changes when different types of words (nonword/regular/exception/voweled/unvoweled) are analysed.

4.2.7. Results for research question 3b.

Within reading accuracy and fluency, does the relationship between morphological awareness and reading differ depending on the type of word (nonword/regular/exception/voweled/unvoweled) within each language?

A non-parametric partial correlations analysis was carried out to determine whether MA and different types of word reading were associated whilst controlling for phonological processing. This analysis was carried out on the whole sample (N = 53) and the different type of words were used (nonword, regular, exception, voweled, unvoweled) as the dependent variables. As before, vocabulary was also controlled for in both languages. There was no association between MA and all types of English word reading accuracy and fluency whilst controlling for phonological processing and receptive vocabulary [MA and exception word reading accuracy ($r(47) = 0.20, p = .18$), MA and regular word reading accuracy ($r(47) = 0.14, p = .34$), MA and nonword reading accuracy ($r(47) = 0.24, p = .10$), MA and real word reading fluency ($r(47) = 0.17, p = .24$), and MA and nonword reading fluency ($r(47) = 0.05, p = .72$)]. In Arabic, however, there was an association between MA and all types of Arabic word reading accuracy whilst controlling for phonological processing and receptive vocabulary [MA and nonword reading accuracy ($r(47) = 0.35, p = .02$), MA and voweled reading accuracy ($r(47) = 0.42, p = .002$), MA and unvoweled reading accuracy ($r(47) = 0.36, p = .01$)]. There was an association between MA and Arabic nonword reading fluency ($r(47) = 0.33, p = .02$), but there was no association between MA and Arabic real word reading fluency, which was voweled, ($r(47) = 0.28, p = .05$) whilst controlling for phonological processing and receptive vocabulary. Although there was no association between MA and Arabic real word reading fluency, the p-value was exactly 0.05 while the p-value for MA and Arabic nonword reading fluency was 0.02. As the arbitrary cut-off point for significance was set at 0.05, both analyses are just below or just above this cut-off point. Therefore, there is no difference between the two analyses in terms of the association between MA and the two types of reading fluency measures. This analysis provided a more detailed picture of the relationship between MA and different word types in the entire sample of bilinguals. The next section will assess the relationship MA and reading based on word type within the TD and RD groups separately to identify whether this relationship changes depending on whether the child has a reading difficulty or not. Also, since this analysis was carried out on the entire sample of bilinguals (N = 53), then it has more power than the next analysis which will be carried out on smaller samples, the TD group (n = 34) and the RD group (n = 19).

4.2.8. Results for research question 3c.

Within reading accuracy and fluency, does the relationship between morphological awareness and reading differ depending on the type of word (nonword/regular/exception/voweled/unvoweled) within each language in each of the two groups (TD and RD) whilst controlling for phonological processing?

A non-parametric partial correlations analysis was carried out to explore the relationship between MA and different types of reading accuracy/fluency whilst controlling for phonological processing within the TD and RD groups separately. Receptive vocabulary was controlled for in the previous analysis because of the difference in scores between the TD and RD groups. Since this analysis was carried out on the TD and RD groups separately, then it was not necessary to control for vocabulary. Results (shown in Table 13) showed that for English reading accuracy, after controlling for phonological processing, MA was significantly associated with exception word reading, but this was only true in the TD group, and not the RD group. MA was not significantly associated with nonword or regular word reading in either group as seen in Table 13. This suggests that MA accounted for more unique variance in exception word reading than in regular or nonword reading in the TD group but not the RD group. As for English reading fluency, after controlling for phonological processing, MA was not significantly associated with real word/nonword reading fluency in either the TD or RD group as seen in Table 15. Although there wasn't a significant association between MA and reading fluency, there was a higher magnitude of association of 0.35 between MA and real word reading fluency that was found in the TD group only and not the RD group suggesting that MA accounted for more unique variance in real reading fluency in TD children. Overall, MA accounted for more unique variance for TD children when reading exception words accurately or when reading real words at a faster rate while this was not found in RD children.

As for Arabic reading accuracy, after controlling for phonological processing, there was a significant association between MA and voweled word reading in the RD group only and not the TD group. There was also a significant relationship between MA and nonword reading in the TD group and not the RD group, as seen in Table 14. MA was not significantly associated with unvoweled word reading for either group but the magnitude of correlations for both the TD and RD groups were close to 0.3. As for Arabic reading fluency, there was a significant association between MA and Arabic nonword reading fluency in the RD group only and not the TD group as seen in Table 16. Overall, the magnitude of the partial correlations for all types of reading did appear to be higher for Arabic than for English in both groups regardless of whether they were significant or not. This suggests that MA is accounting for more unique variance in Arabic reading measures than English reading measures (apart from exception words), which highlights the importance of MA to Arabic reading in comparison to English reading. Some word-types did not reach significance, although this may have been due to the small sample size and low statistical power so these results should be interpreted with caution. The next section examines the profile of morphological and phonological skills of each participant in the RD group using single-case analyses to understand the profile of each RD child in more detail as opposed to the group analysis carried out in RD children (above).

Table 13. Results of nonparametric zero order (above the diagonal) and partial correlations (below the diagonal) between English reading accuracy measures and morphological awareness before and after controlling for phonological processing measures in the TD (n = 34) and RD (n = 19) groups

	TD				RD			
Variable	1	2	3	4	1	2	3	4
1. Morphological Awareness Composite	—	.41*	.45**	.66**	—	.26	.40	.37
2. Nonword reading accuracy	.17	—	.76**	.56**	-.02	—	.80**	.62**
3. Regular word reading accuracy	.18		—	.60**	.14		—	.88**
4. Exception word reading accuracy	.55**			—	.14			—

*$p < .05$. **$p < .01$. Note: TD refers to typically developing group and RD refers to reading difficulties group. Partial (below diagonal) and zero order (above diagonal) Spearman's rho correlations for variables in Table 13. The degrees of freedom for the TD group = 29 and the RD group = 14.

Table 14. Results of nonparametric zero order and partial correlations between Arabic reading accuracy measures and morphological awareness whilst controlling for phonological processing measures in the TD (n = 34) and RD (n = 19) groups

	TD				RD			
Variable	1	2	3	4	1	2	3	4
1. Morphological Knowledge Composite	—	.48**	.43*	.40*	—	.36	.63**	.60**
2. Nonword reading accuracy	.41*	—	.82**	.65**	.08	—	.67**	.76**
3. Voweled word reading accuracy	.33		—	.69**	.52*		—	.70**
4. Unvoweled word reading accuracy	.28			—	.32			—

*$p < .05$. **$p < .01$. ***$p < .001$. Note: TD refers to typically developing group and RD refers to reading difficulties group. Partial (below diagonal) and zero order (above diagonal) Spearman's rho Correlations for Variables in Table 14. The degrees of freedom for the TD group = 29 and the RD group = 14.

Table 15. Results of nonparametric zero order and partial correlations between English reading fluency measures and morphological awareness whilst controlling for phonological processing measures in the TD (n = 34) and RD (n = 19) groups

	TD			RD		
Variable	1	2	3	1	2	3
1. Morphological Knowledge Composite	—	.24	.50**	—	.18	.31
2. Nonword reading fluency	-.05	—	.71**	-.15	—	.58**
3. Real word reading fluency	.35		—	.16		—

*$p < .05$. **$p < .01$. ***$p < .001$. Note: TD refers to typically developing group and RD refers to reading difficulties group. Partial (below diagonal) and zero order (above diagonal) Spearman's rho correlations for variables in Table 13. The degrees of freedom for the TD group = 29 and the RD group = 14.

Table 16. Results of nonparametric zero order and partial correlations between Arabic reading fluency measures and morphological awareness whilst controlling for phonological processing measures in the TD (n = 34) and RD (n = 19) groups

	TD			RD		
Variable	1	2	3	1	2	3
1. Morphological Knowledge Composite	—	.34	.36*	—	.76***	.51*
2. Nonword reading fluency	.21	—	.68**	.60**	—	.70**
3. Real word reading fluency	.26		—	.17		—

*$p < .05$. **$p < .01$. ***$p < .001$. Note: TD refers to typically developing group and RD refers to reading difficulties group. Partial (below diagonal) and zero order (above diagonal) Spearman's rho correlations for variables in Table 14. The degrees of freedom for the TD group = 29 and the RD group = 14.

4.2.9. Results for research question 4a.

Upon examining the profile of children with reading difficulties individually: do they show a deficit in phonological awareness, morphological knowledge, both, or neither in each language? Is there a dissociation between PA and MA?

In this section, Crawford & Garthwaite's (2005b) single-case analysis methods were used, described in section 3.10., to test whether each case shows a deficit in phonological awareness (elision task X) and the morphological awareness task (judgement Y_1). The computer program "Dissocs_ES.exe" (Crawford et al., 2010) was used to calculate whether each case shows a deficit in each of these tasks using Crawford & Howell (1998) modified *t*-test. A lower *p* value of .025 (one-tailed) was used since the control group's data in this study is non-normal as advised by Crawford & Garthwaite (2005b). An effect size was reported which is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation with an accompanying 95% confidence interval (Crawford et al., 2010). This *z* score was reported for effect size purposes and not for significance testing and is denoted Z_{cc}. Next, the program calculated the RSDT (Crawford & Garthwaite, 2005b) to test whether there was a significant difference between each case's standardized difference in scores between the two tasks X and Y_1 when compared to the distribution of the standardized differences between tasks X and Y_1 in the controls. An effect size for the difference between the two scores (Z_{dcc}) was reported using the equation (3) where X* is the case's raw score for task X, $\overline{X}$ is the mean of the control sample on task X, Y* is the case's raw score for task Y, $\overline{Y}$ is the mean of the control sample on task Y, and S_x and S_y are the control sample standard deviations on task X and task Y, respectively. Finally, r is the correlation coefficient between task X and task Y in the control sample. Again, this *z* score was reported as an effect size and was not used for significance testing. This effect size (Z_{dcc}) was reported along with a 95% confidence interval that was calculated by the program using Bayesian methods, see Appendix 9 for the detailed calculation and equation (Crawford & Garthwaite, 2007).

$$Z_{dcc} = \frac{\left[\frac{X^* - \overline{X}}{S_x}\right] - \left[\frac{Y^* - \overline{y}}{S_y}\right]}{\sqrt{2 - 2\mathrm{r}}} \qquad (3)$$

If the case was significantly impaired on one of the tasks and not the other compared to the control group ($p < 0.025$, one-tailed) and the standardized difference between the two tasks was significantly different from that of the control group ($p < 0.025$, two-tailed), then the case was said to have a classical dissociation (Crawford & Garthwaite, 2005b). If the case was significantly impaired on both tasks compared to the control group ($p < 0.025$, one-tailed) and the standardized difference between the two tasks was significantly different from that of the control group ($p < 0.025$, two-tailed), then the case was said to have a strong dissociation. This analysis was repeated for each case for tasks elision X and Judgement Y_1, elision X and analogy Y_2, in both English and Arabic. This study used two different tests to measure the construct of MA. Using several tests to measure a construct decreases the chance of making incorrect conclusions (Crawford & Garthwaite, 2005a). However, Crawford & Garthwaite (2005b) state that combining probabilities of dissociations from these several different tasks is complex and is yet to be developed. Therefore, the probabilities of dissociations for these tasks were reported and analysed separately.

Children with RD are heterogenous and may show different strength and weaknesses in terms of their PA and MA skills. This is why the section below reports these different levels of PA and MA skills on a single case basis. One of the reasons for analysing dissociations is to observe whether cases with RD show a dissociation between their phonological and morphological skills. Cavalli et al. (2017) argue that cases with very low PA skills need to have very strong MA skills to be able to use those skills to compensate when reading. Whereas cases with not so weak phonological awareness skills may not utilise their morphological skills when reading. Whether each case shows a deficit or not on the phonological and morphological tasks is reported for each case below, and whether there is a dissociation between those skills for each case is also reported below as this dissociation (higher deficit for phonological skill than morphological skill) could mean that RD children may be able to use their morphological skills to compensate for weaknesses in their phonological skills.

4.2.9.1. Case 1

As shown in Table 17, which summarizes the English results for Case 1, the case met the criteria for a deficit on the PA task and did not meet the criteria for a deficit on the morphological judgement task. Since the standardized differences between phonological awareness task and the morphological judgement task was statistically different from the control sample, then this case met the criteria for a classical dissociation on this task. The same results were found as well between the PA task and the morphological analogy task. Therefore, Case 1 showed a classical dissociation between PA and MA tasks (both types).

As for the Arabic results for Case 1, shown in Table 18, the case met the criteria for a deficit on the PA task and met the criteria for a deficit on the morphological judgement task. However, since the standardized differences between PA and the morphological judgement task was not statistically different from the control sample, then this case did not meet the criteria for a dissociation on this task. The same results were found between the PA task and the morphological analogy task. Therefore, Case 1 had weak PA and MA in Arabic, but did not show a dissociation between PA and MA (both types).

Figure 7 summarizes the *z* scores for the English tasks on the left of the figure, and it can be clearly seen that there was a dissociation between the PA task and MA tasks in English, whereas no dissociation was seen between the PA task and the MA tasks in Arabic, which are shown on the right of the figure. The figures for the rest of the cases are provided in Appendix 10 and the results of all cases are summarized in the next section.

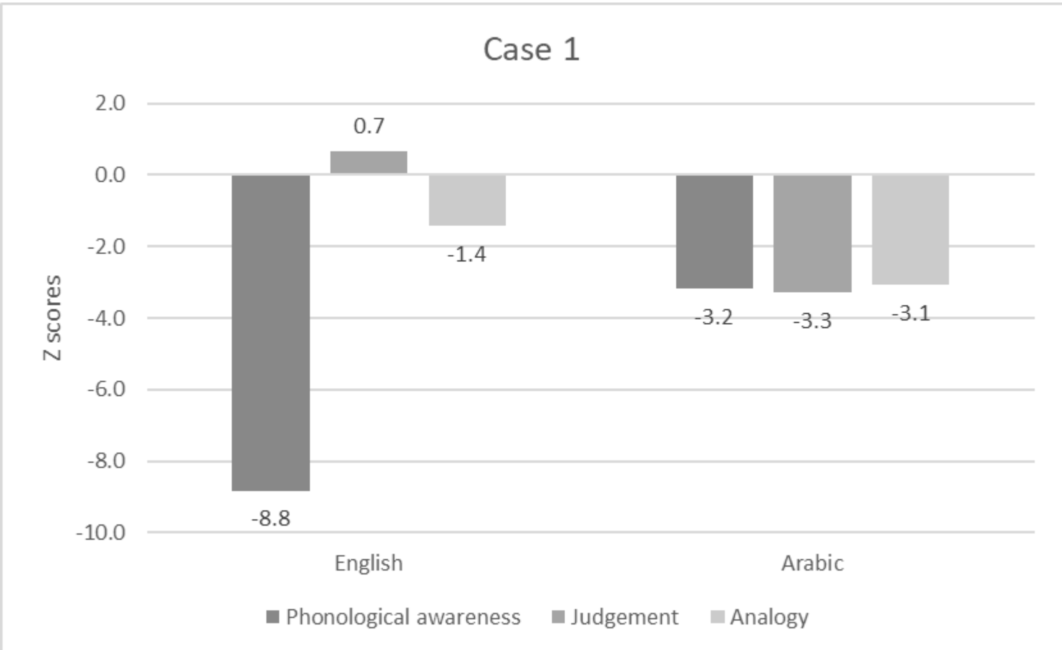

Figure 7. Case 1 z-scores on PA and MA tasks in English and Arabic

Table 17. Results of comparing Case 1 to control sample using single-case analysis on English tasks

Task	Control sample				Effect size (Z_{cc})		Significance test[a]		Effect size (Z_{dcc})		Significance test[b]	
	n	*M*	*SD*	Case score	*Point*	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*
Phonological awareness	34	18	1.7	3	-8.82	(-10.97 to -6.68)	-8.7	<.001				
Judgement task	34	16	3.1	18	0.65	(0.27 to 1.01)	0.64	.26	-7.58	(-9.86 to -5.56)	7.27	<.001
Analogy task	34	15	2.1	12	-1.43	(-1.90 to -0.94)	-1.41	.08	-5.74	(-7.81 to -3.92)	5.53	<.001

Note: Includes reporting point and interval estimates of the effect size (Z_{cc}) and (Z_{dcc}) for the differences between case and controls using the method set out in the following papers:

[a]Crawford & Howell (1998); the results are for a one-tailed test to test whether the case's scores are significantly lower than that of the control sample.

[b]Crawford & Garthwaite (2005b); the results are for a two-tailed test to test whether the standardized differences between the two tasks is statistically different from the distribution of differences in the control sample.

Z_{cc} is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation.

Z_{dcc} is an effect size for the difference between the two scores on the two tasks calculated using equation (3) above.

Table 18. Results of comparing Case 1 to control sample using single-case analysis on Arabic tasks

Task	Control sample				Effect size (Z_{cc})		Significance test[a]		Effect size (Z_{dcc})		Significance test[b]	
	n	*M*	*SD*	Case score	*Point*	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*
Phonological awareness	34	15	2.2	8	-3.18	(-4.01 to -2.34)	-3.14	.002				
Judgement task	34	18	1.8	12	-3.33	(-4.20 to -2.46)	-3.29	.001	0.11	(-0.76 to 0.99)	0.11	.92
Analogy task	34	14	3.9	2	-3.08	(-3.89 to -2.26)	-3.03	.002	-0.09	(-1.02 to 0.84)	0.09	.93

Note: Includes reporting point and interval estimates of the effect size (Z_{cc}) and (Z_{dcc}) for the differences between case and controls using the method set out in the following papers:
[a]Crawford & Howell (1998); the results are for a one-tailed test to test whether the case's scores are significantly lower than that of the control sample.

[b]Crawford & Garthwaite (2005b); the results are for a two-tailed test to test whether the standardized differences between the two tasks is statistically different from the distribution of differences in the control sample.
Z_{cc} is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation.

Z_{dcc} is an effect size for the difference between the two scores on the two tasks calculated using equation (3) above.

4.2.9.2. Summary of single case analysis results

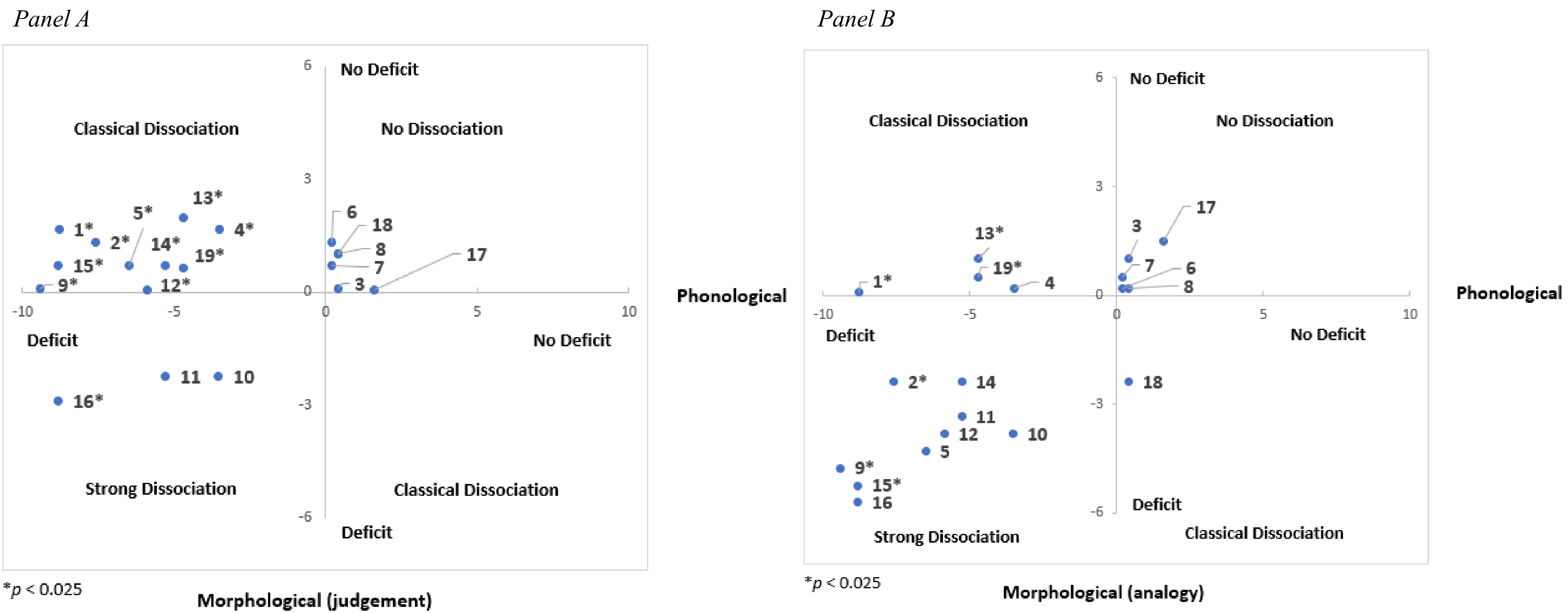

Figure 8. Diagram summarizing the profiles of each RD case number comparing English z scores to controls, Panel A shows the morphological judgement task (Y-axis), Panel B shows the morphological analogy task (Y-axis), both panels show phonological awareness task (X-axis), case numbers with asterisks represent cases who met the criteria for a dissociation (classical/strong)

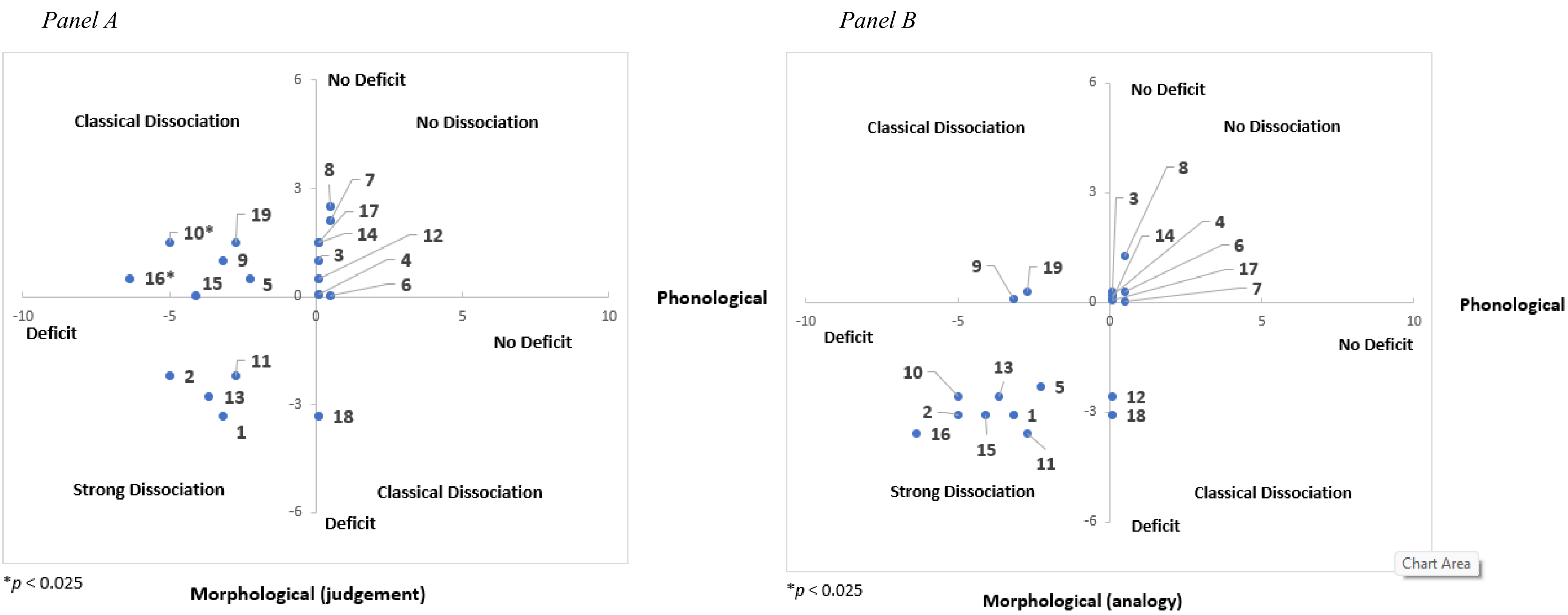

Figure 9. Diagram summarizing the profiles of each RD case number comparing Arabic z scores to controls, Panel A shows the morphological judgement task (Y-axis), Panel B shows the morphological analogy task (Y-axis), both panels show phonological awareness task (X-axis), case numbers with asterisks represent cases who met the criteria for a dissociation (classical/strong)

For the English results, Figure 8 above summarizes the case numbers along z score axes, the x-axis represents the phonological scores, and the y-axis represents the morphological scores. The position of the point on the axes indicates whether or not the case showed a deficit on each task (whether the case's scores were significantly lower than that of the control sample). The asterisk indicates that the case met the criteria for a classical dissociation or a strong dissociation (the standardized differences between the two tasks was statistically different from the distribution of differences in the control sample). The case numbers without asterisks in Figure 8 indicate their position along the axes in relation to their score on the phonological and morphological task only and did not meet the criteria for a dissociation (the standardized differences between the two tasks was not statistically different from the distribution of differences in the control sample). Panel A shows the morphological judgement task while the morphological analogy task is shown in Panel B. For Panel A, cases 1, 2, 4, 5, 9, 12, 13, 14, 15, and 19 showed a deficit on the phonological task only and not on the morphological judgement task, and results summarized in Table 19 below indicated that these cases met the criteria for a classical dissociation. Cases 10, 11, and 16 showed a deficit on both the phonological task and the morphological judgement task, but only case 16 met the criteria for a strong dissociation. Cases 3, 6, 7, 8, 17, and 18 did not show a deficit on either the phonological task nor the morphological judgement task and therefore did not meet the criteria for a dissociation. None of the cases showed a deficit on the morphological judgement task only and not the phonological task.

As for the morphological analogy task summarized in Panel B of Figure 8 above, only cases 1, 4, 13 and 19 showed a deficit on the phonological task only and not the morphological analogy task, and of those cases only cases 1, 13, and 19 met the criteria for a classical dissociation as shown in Table 20 (the standardized differences between the two tasks was statistically different from the distribution of differences in the control sample). Cases 2, 5, 9, 10, 11, 12, 14, 15 and 16 all showed a deficit on both the phonological task as well as the morphological analogy task, but only cases 2, 9, and 15 met the criteria for a strong dissociation. Cases 3, 6, 7, 8, and 17 showed no deficit on either of the two tasks and therefore showed no dissociation. Case 18 showed a deficit on the morphological analogy task and not the phonological task but did not meet the criteria for a classical dissociation.

Overall, six cases in English (Case 1, 2, 9, 13, 15, and 19) showed either a classic or a strong dissociation between the phonological task and both morphological tasks, which provided the strongest evidence of a dissociation between the phonological and morphological skill. Five cases (4, 5, 12, 14, and 16) showed a classical or strong dissociation between the phonological task and only the morphological judgement task, which provides weaker evidence of a dissociation between the phonological and morphological skill. Finally, eight cases (3, 6, 7, 8, 10, 11, 17, and 18) showed no dissociation between the phonological task and either of the morphological tasks.

As for Arabic, Figure 9 above summarizes each case's score on the phonological and morphological task. As before, Panel A shows the morphological judgement task while the morphological analogy task is shown in Panel B. For Panel A, cases 5, 9, 10, 15, 16, and 19 showed a deficit on the phonological task only and not on the morphological judgement task, and results summarized in Table 21 below indicated that only cases 10 and 16 met the criteria for a classical dissociation. Cases 1, 2, 11 and 13 showed a deficit on both the phonological task and the morphological judgement task, but none of the cases met the criteria for a strong dissociation. Cases 3, 4, 6, 7, 8, 12, 14, and 17 did not show a deficit on either the phonological task nor the morphological judgement task and therefore did not meet the criteria for a dissociation. Case 18 showed a deficit on the morphological judgement task only and not the phonological task but did not meet the criteria for a classical dissociation.

As for the morphological analogy task summarized in Panel B of Figure 9 above, only cases 9 and 19 showed a deficit on the phonological task only and not the morphological analogy task, and none of those cases met the criteria for a classical dissociation as shown in Table 22. Cases 1, 2, 5, 10, 11, 13, 14, 15 and 16 all showed a deficit on both the phonological task as well as the morphological analogy task, but none of the cases met the criteria for a strong dissociation. Cases 3, 4, 6, 7, 8, 14 and 17 showed no deficit on either of the two tasks and therefore showed no dissociation. Case 12 and 18 showed a deficit on the morphological analogy task and not the phonological task but did not meet the criteria for a classical dissociation.

Overall, zero cases in Arabic showed either a classic or a strong dissociation between the phonological task and both morphological tasks, which did not provide strong evidence of a dissociation between the phonological and morphological skill in any of these children, in contrast to the results for the English tasks. Two cases (10 and 16) showed a classical dissociation between the phonological task and only the morphological judgement task, which provides weaker evidence of a dissociation between phonological and morphological skill. Finally, most of the cases showed no dissociation between the phonological task and either of the morphological tasks.

There was more evidence of a dissociation between phonological and morphological skills in English than in Arabic. For English, children either had a phonological deficit in the absence of a morphological deficit or had a much larger phonological deficit than a morphological deficit. The next section analyses whether the dissociation of the phonological and morphological skill is associated with the RD children's reading performance. If so, this might indicate that children may be using morphological skills to compensate for poor phonological skills, and if so, whether they are more able to do this in English or Arabic.

Table 19. Results of comparing all cases to control sample using single-case analysis on English judgement task

Case number	Effect size (Z_{cc}) Task X		Significance test[a]		Effect size (Z_{cc}) Task Y		Significance test[a]		Effect size (Z_{dcc})		Significance test[b]	
	Point	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*
Case 1	-8.82	(-10.97 to -6.68)	-8.7	<.001	0.65	(0.27 to 1.01)	0.64	.26	-7.58	(-9.86 to -5.56)	7.3	<.001
Case 2	-7.65	(-9.51 to -5.78)	-7.5	<.001	0.32	(-0.025 to 0.67)	0.32	.38	-6.38	(-8.34 to -4.65)	6.1	<.001
Case 3	-0.59	(-0.95 to -0.22)	-0.6	0.28	-0.97	(-1.37 to -0.55)	-0.95	.17	0.30	(-0.09 to 0.71)	0.29	.77
Case 4	-3.53	(-4.44 to -2.61)	-3.5	<.001	0.65	(0.27 to 1.01)	0.64	.26	-3.34	(-4.34 to -2.44)	3.23	.003
Case 5	-6.47	(-8.06 to -4.88)	-6.4	<.001	-0.32	(-0.67 to 0.03)	-0.32	.38	-4.92	(-6.54 to -3.49)	4.74	<.001
Case 6	-1.77	(-2.30 to -1.22)	-1.7	.05	0.32	(-0.025 to 0.67)	0.32	.38	-1.67	(-2.25 to -1.13)	1.62	.12
Case 7	-1.77	(-2.30 to -1.22)	-1.7	.05	-0.32	(-0.67 to 0.03)	-0.32	.38	-1.16	(-1.69 to -0.66)	1.12	.27
Case 8	-0.59	(-0.95 to -0.22)	-0.6	.28	0.00	(-0.34 to 0.34)	0.00	.50	-0.47	(-0.84 to -0.11)	0.46	.65
Case 9	-9.41	(-11.69 to -7.12)	-9.3	<.001	-0.97	(-1.37 to -0.55)	-0.95	.17	-6.76	(-9.06 to -4.74)	6.49	<.001
Case 10	-3.53	(-4.44 to -2.61)	-3.5	<.001	-2.26	(-2.89 to -1.62)	-2.23	.02	-1.02	(-1.92 to -0.17)	0.98	.33
Case 11	-5.29	(-6.61 to -3.98)	-5.2	<.001	-2.26	(-2.89 to -1.62)	-2.23	.02	-2.43	(-3.70 to -1.29)	2.35	.025
Case 12	-5.88	(-7.33 to -4.43)	-5.8	<.001	-1.29	(-1.74 to -0.83)	-1.27	.11	-3.68	(-5.10 to -2.42)	3.55	.001

Case 13	-4.71	(-5.88 to -3.52)	-4.6	<.001	0.97	(0.55 to 1.37)	0.95	.17	-4.54	(-5.86 to -3.36)	4.38	<.001
Case 14	-5.29	(-6.61 to -3.98)	-5.2	<.001	-0.32	(-0.67 to 0.03)	-0.32	.38	-3.98	(-5.32 to -2.80)	3.84	<.001
Case 15	-8.82	(-10.97 to -6.68)	-8.7	<.001	-0.32	(-0.67 to 0.03)	-0.32	.38	-6.81	(-9.0 to -4.87)	6.54	<.001
Case 16	-8.82	(-10.97 to -6.68)	-8.7	<.001	-2.90	(-3.67 to -2.13)	-2.86	.003	-4.74	(-6.81 to -2.90)	4.57	<.001
Case 17	0.59	(0.22 to 0.95)	0.6	.28	-0.29	(-1.74 to -0.83)	-1.27	.11	1.50	(1.02 to 2.02)	1.46	.16
Case 18	-0.59	(-0.95 to -0.22)	-0.6	.28	0.00	(-0.34 to 0.34)	0.00	.50	-0.47	(-0.84 to -0.11)	0.46	.65
Case 19	-4.71	(-5.88 to -3.52)	-4.6	<.001	0.65	(0.27 to 1.01)	0.64	.26	-4.28	(-5.56 to -3.14)	4.13	<.001

Note: Includes reporting point and interval estimates of the effect size (Z_{cc}) and (Z_{dcc}) for the differences between case and controls using the method set out in the following papers:
[a]Crawford & Howell (1998); the results are for a one-tailed test to test whether the case's scores are significantly lower than that of the control sample.

[b]Crawford & Garthwaite (2005b); the results are for a two-tailed test to test whether the standardized differences between the two tasks is statistically different from the distribution of differences in the control sample.
Z_{cc} is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation.

Z_{dcc} is an effect size for the difference between the two scores on the two tasks (phonological and morphological) calculated using equation (3) above. Task X refers to the phonological task and Task Y refers to the morphological judgement task.

Table 20. Results of comparing all cases to control sample using single-case analysis on English analogy task

Case number	Effect size (Z_{cc}) Task X		Significance test[a]		Effect size (Z_{cc}) Task Y		Significance test[a]		Effect size (Z_{dcc})		Significance test[b]	
	Point	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*
Case 1	-8.82	(-10.97 to -6.68)	-8.7	<.001	-1.43	(-1.90 to -0.94)	-1.41	.08	-5.74	(-7.81 to -3.92)	5.53	<.001
Case 2	-7.65	(-9.51 to -5.78)	-7.5	<.001	-2.38	(-3.04 to -1.71)	-2.35	.01	-4.09	(-5.85 to -2.52)	3.95	<.001
Case 3	-0.59	(-0.95 to -0.22)	-0.6	0.28	0.00	(-0.34 to 0.34)	0.00	.50	-0.46	(-0.82 to -0.1)	0.44	.66
Case 4	-3.53	(-4.44 to -2.61)	-3.5	<.001	-0.95	(-1.35 to -0.54)	-0.94	.18	-2.00	(-2.87 to -1.22)	1.94	.06
Case 5	-6.47	(-8.06 to -4.88)	-6.4	<.001	-4.29	(-5.36 to -3.20)	4.22	<.001	-1.70	(-3.24 to -0.25)	1.64	.11
Case 6	-1.77	(-2.30 to -1.22)	-1.7	.05	-0.95	(-1.35 to -0.54)	-0.94	.18	-0.63	(-1.15 to -0.13)	0.61	.55
Case 7	-1.77	(-2.30 to -1.22)	-1.7	.05	-0.48	(-0.83 to -0.12)	-0.47	.32	-1.00	(-1.52 to -0.51)	0.97	.34
Case 8	-0.59	(-0.95 to -0.22)	-0.6	.28	-0.95	(-1.35 to -0.54)	-0.94	.18	0.28	(-0.11 to 0.68)	0.27	.79
Case 9	-9.41	(-11.69 to -7.12)	-9.3	<.001	-4.76	(-5.95 to -3.57)	-4.69	<.001	-3.61	(-5.77 to -1.65)	3.49	.001
Case 10	-3.53	(-4.44 to -2.61)	-3.5	<.001	-3.81	(-4.78 to -2.83)	-3.76	<.001	0.22	(-0.79 to 1.24)	0.21	.83
Case 11	-5.29	(-6.61 to -3.98)	-5.2	<.001	-3.33	(-4.20 to -2.46)	-3.29	.001	-1.52	(-2.79 to -0.34)	1.47	.15
Case 12	-5.88	(-7.33 to -4.43)	-5.8	<.001	-3.81	(-4.78 to -2.83)	-3.76	<.001	-1.61	(-3.02 to -0.30)	1.56	.13
Case 13	-4.71	(-5.88 to -3.52)	-4.6	<.001	0.00	(-0.34 to 0.34)	0.00	.50	-3.65	(-4.84 to -2.60)	3.53	.001

Case 14	-5.29	(-6.61 to -3.98)	-5.2	<.001	-2.38	(-3.04 to -1.71)	-2.35	.01	-2.26	(-3.51 to -1.14)	2.19	.04
Case 15	-8.82	(-10.97 to -6.68)	-8.7	<.001	-5.24	(-6.54 to -3.93)	-8.70	<.001	-2.78	(-4.84 to -0.89)	2.69	.01
Case 16	-8.82	(-10.97 to -6.68)	-8.7	<.001	-5.71	(-7.12 to -4.30)	-5.63	<.001	-2.41	(-4.49 to -0.48)	2.33	.03
Case 17	0.59	(0.22 to 0.95)	0.6	.28	0.48	(0.12 to 0.83)	0.47	.32	0.09	(-0.28 to 0.45)	0.08	.93
Case 18	-0.59	(-0.95 to -0.22)	-0.6	.28	-2.38	(-3.04 to -1.71)	-2.35	.01	1.39	(0.80 to 2.03)	1.35	.19
Case 19	-4.71	(-5.88 to -3.52)	-4.6	<.001	-0.48	(-0.83 to -0.12)	-0.47	.32	-3.28	(-4.44 to -2.26)	3.17	.003

Note: Includes reporting point and interval estimates of the effect size (Z_{cc}) and (Z_{dcc}) for the differences between case and controls using the method set out in the following papers:
[a]Crawford & Howell (1998); the results are for a one-tailed test to test whether the case's scores are significantly lower than that of the control sample.

[b]Crawford & Garthwaite (2005b); the results are for a two-tailed test to test whether the standardized differences between the two tasks is statistically different from the distribution of differences in the control sample.
Z_{cc} is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation.

Z_{dcc} is an effect size for the difference between the two scores (phonological and morphological) calculated using equation (3) above. Task X refers to the phonological task and Task Y refers to the morphological analogy task.

Table 21. Results of comparing all cases to control sample using single-case analysis on Arabic judgement task

Case number	Effect size (Z_{cc}) Task X		Significance test[a]		Effect size (Z_{cc}) Task Y		Significance test[a]		Effect size (Z_{dcc})		Significance test[b]	
	Point	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*
Case 1	-3.18	(-4.01 to -2.34)	-3.1	.002	-3.33	(-4.20 to -2.46)	-3.29	.001	0.11	(-0.76 to 0.99)	0.11	.92
Case 2	-5.00	(-6.24 to -3.75)	-4.9	<.001	-2.22	(-2.85 to -1.59)	-2.19	.018	-2.02	(-3.14 to -1.00)	1.95	.06
Case 3	-0.91	(-1.31 to -0.50)	-0.9	.19	0.00	(-0.34 to 0.34)	0.00	.50	-0.66	(-1.05 to -0.28)	0.64	.53
Case 4	-0.91	(-1.31 to -0.50)	-0.9	.19	-1.67	(-2.18 to -1.14)	-1.64	.05	0.55	(0.08 to 1.04)	0.53	.60
Case 5	-2.27	(-2.91 to -1.63)	-2.2	.016	-0.56	(-0.91 to -0.19)	-0.55	.29	-1.25	(-1.84 to -0.70)	1.21	.24
Case 6	-0.46	(-0.81 to -0.10)	-0.5	.33	-1.11	(-1.54 to -0.68)	-1.10	.14	0.48	(0.08 to 0.89)	0.46	.65
Case 7	-0.46	(-0.81 to -0.10)	-0.5	.33	1.11	(0.68 to 1.54)	1.10	.14	-1.14	(-1.59 to -0.70)	1.1	.28
Case 8	-0.46	(-0.81 to -0.10)	-0.5	.33	0.56	(0.19 to 0.91)	0.55	.29	-0.73	(-1.12 to -0.36)	0.71	.48
Case 9	-3.18	(-4.01 to -2.34)	-3.1	.002	0.00	(-0.34 to 0.34)	0.00	.50	-2.31	(-3.11 to -1.59)	2.24	.03
Case 10	-5.00	(-6.24 to -3.75)	-4.9	<.001	0.56	(0.19 to 0.91)	0.55	.29	-4.03	(-5.26 to -2.93)	3.90	<.001
Case 11	-2.73	(-3.46 to -1.99)	-2.7	.006	-2.22	(-2.85 to -1.59)	-2.19	.018	-0.37	(-1.08 to 0.33)	0.36	.72
Case 12	-1.82	(-2.36 to -1.26)	-1.8	.04	-0.56	(-0.91 to -0.19)	-0.55	.29	-0.92	(-1.43 to -0.44)	0.89	.38
Case 13	-3.64	(-4.57 to -2.70)	-3.6	<.001	-2.78	(-3.52 to -2.03)	-2.74	.005	-0.62	(-1.51 to 0.23)	0.60	.55

Case 14	-1.82	(-2.36 to -1.26)	-1.8	.04	0.56	(0.19 to 0.91)	0.55	.29	-1.72	(-2.30 to -1.19)	1.67	.10
Case 15	-4.09	(-5.13 to -3.05)	-4.0	<0.001	-1.67	(-2.18 to -1.14)	-1.64	.05	-1.76	(-2.70 to -0.91)	1.71	.10
Case 16	-6.36	(-7.92 to -4.80)	-6.3	<0.001	-0.56	(-0.91 to -0.19)	-0.55	.29	-4.21	(-5.67 to -2.93)	4.08	<.001
Case 17	-1.82	(-2.36 to -1.26)	-1.8	.04	0.56	(0.19 to 0.91)	0.55	.29	-1.72	(-2.30 to -1.19)	1.67	.10
Case 18	-1.82	(-2.36 to -1.26)	-1.8	.04	-3.33	(-4.20 to -2.46)	-3.29	.001	1.10	(0.36 to 1.89)	1.07	.29
Case 19	-2.73	(-3.46 to -1.99)	-2.7	.006	0.56	(0.19 to 0.91)	0.55	.29	-2.38	(-3.13 to -1.70)	2.31	.027

Note: Includes reporting point and interval estimates of the effect size (Z_{cc}) and (Z_{dcc}) for the differences between case and controls using the method set out in the following papers:
[a]Crawford & Howell (1998); the results are for a one-tailed test to test whether the case's scores are significantly lower than that of the control sample.

[b]Crawford & Garthwaite (2005b); the results are for a two-tailed test to test whether the standardized differences between the two tasks is statistically different from the distribution of differences in the control sample.
Z_{cc} is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation.

Z_{dcc} is an effect size for the difference between the two scores on the two (phonological and morphological) calculated using equation (3) above. Task X refers to the phonological task and Task Y refers to the morphological judgement task.

Table 22. Results of comparing all cases to control sample using single-case analysis on Arabic analogy task

Case number	Effect size (Z_{cc}) Task X		Significance test[a]		Effect size (Z_{cc}) Task Y		Significance test[a]		Effect size (Z_{dcc})		Significance test[b]	
	Point	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*	*Point*	*(95% CI)*	*t*	*p*
Case 1	-3.18	(-4.01 to -2.34)	-3.1	.002	-3.08	(-3.89 to -2.26)	-3.03	.002	-0.09	(-1.02 to 0.84)	0.09	.93
Case 2	-5.00	(-6.24 to -3.75)	-4.9	<.001	-3.08	(-3.89 to -2.26)	-3.03	.002	-1.66	(-2.94 to -0.47)	1.60	0.12
Case 3	-0.91	(-1.31 to -0.50)	-0.9	.19	-1.03	(-1.44 to -0.60)	-1.01	.16	0.10	(-0.33 to 0.53)	0.10	.92
Case 4	-0.91	(-1.31 to -0.50)	-0.9	.19	-1.28	(-1.73 to -0.82)	-1.26	.11	0.32	(-0.13 to 0.79)	0.31	.76
Case 5	-2.27	(-2.91 to -1.63)	-2.2	.016	-2.31	(-2.95 to -1.65)	-2.27	.01	0.03	(-0.69 to 0.75)	0.03	.98
Case 6	-0.46	(-0.81 to -0.10)	-0.5	.33	-1.03	(-1.44 to -0.60)	-1.01	.16	0.49	(0.09 to 0.91)	0.48	.64
Case 7	-0.46	(-0.81 to -0.10)	-0.5	.33	-2.05	(-2.64 to -1.45)	-2.02	.025	1.38	(0.82 to 1.99)	1.33	.19
Case 8	-0.46	(-0.81 to -0.10)	-0.5	.33	0.26	(-0.09 to 0.60)	0.25	.40	-0.61	(-0.99 to -0.25)	0.59	.56
Case 9	-3.18	(-4.01 to -2.34)	-3.1	.002	-1.54	(-2.03 to -1.03)	-1.52	.07	-1.42	(-2.26 to -0.64)	1.37	.18
Case 10	-5.00	(-6.24 to -3.75)	-4.9	<.001	-2.56	(-3.26 to -1.86)	-2.53	.008	-2.10	(-3.37 to -0.95)	2.03	.05
Case 11	-2.73	(-3.46 to -1.99)	-2.7	.006	-3.59	(-4.51 to -2.66)	-3.54	<.001	0.75	(-0.19 to 1.72)	0.72	.48
Case 12	-1.82	(-2.36 to -1.26)	-1.8	.04	-2.56	(-3.26 to -1.86)	-2.53	.008	0.64	(-0.05 to 1.37)	0.62	.54
Case 13	-3.64	(-4.57 to -2.70)	-3.6	<.001	-2.56	(-3.26 to -1.86)	-2.53	.008	-0.93	(-1.90 to -0.001)	0.89	.38

Case 14	-1.82	(-2.36 to -1.26)	-1.8	.04	-1.54	(-2.03 to -1.03)	-1.52	.07	-0.24	(-0.82 to 0.33)	0.23	.82
Case 15	-4.09	(-5.13 to -3.05)	-4.0	<0.001	-3.08	(-3.89 to -2.26)	-3.03	.002	-0.88	(-1.97 to 0.17)	0.85	.40
Case 16	-6.36	(-7.92 to -4.80)	-6.3	<0.001	-3.59	(-4.51 to -2.66)	-3.54	<.001	-2.40	(-3.99 to -0.93)	2.31	.03
Case 17	-1.82	(-2.36 to -1.26)	-1.8	.04	-1.80	(-2.34 to -1.24)	-1.77	.04	-0.02	(-0.62 to 0.58)	0.02	.98
Case 18	-1.82	(-2.36 to -1.26)	-1.8	.04	-3.08	(-3.89 to -2.26)	-3.03	.002	1.09	(0.31 to 1.91)	1.05	.30
Case 19	-2.73	(-3.46 to -1.99)	-2.7	.006	-1.03	(-1.44 to -0.60)	-1.01	.16	-1.47	(-2.21 to -0.79)	1.42	.17

Note: Includes reporting point and interval estimates of the effect size (Z_{cc}) and (Z_{dcc}) for the differences between case and controls using the method set out in the following papers:
[a]Crawford & Howell (1998); the results are for a one-tailed test to test whether the case's scores are significantly lower than that of the control sample.

[b]Crawford & Garthwaite (2005b); the results are for a two-tailed test to test whether the standardized differences between the two tasks is statistically different from the distribution of differences in the control sample.
Z_{cc} is a *z* score calculated by subtracting each case's raw score from the control sample mean divided by the control sample standard deviation.

Z_{dcc} is an effect size for the difference between the two scores on the two tasks (phonological and morphological) calculated using equation (3) above. Task X refers to the phonological task and Task Y refers to the morphological analogy task.

4.2.10. Results for research question 4b.

Is there a relationship between the magnitude of dissociations and reading performance in children with reading difficulties? (are they using their morphological skills to compensate for the weakness in their phonological skills?)

The above analysis provided a detailed picture of the profile of the children in the RD group in terms of their English and Arabic phonological and morphological skills and whether these skills dissociate. Cases with RD have different levels of PA and MA and this is why the section above reported these different levels on a single case basis. One of the reasons for analysing dissociations is to observe whether cases with RD show a dissociation between their phonological and morphological skills. This section analyses whether the dissociation of the phonological and morphological skill in the group of children with RD is associated with their reading performance following methods used by Cavalli et al. (2017). As in the previous section, Cavalli et al.'s study (2017) used the same computer program and calculated the RSDT (Crawford & Garthwaite, 2005b) to test whether there was a significant difference between each case's standardized difference in scores between the two tasks X (phonological) and Y (morphological) when compared to the controls. An effect size for the difference between the two scores (Z_{dcc}) was reported in Tables 19-22 and can also be referred to as the 'magnitude of dissociation' between the two scores. A negative (Z_{dcc}) value indicated that there was a lower phonological score than a morphological score. The higher the difference between the scores the larger the negative value of (Z_{dcc}) indicating a higher 'magnitude of dissociation' in favour of the morphological task. A positive (Z_{dcc}) value indicated that there was a higher phonological score than a morphological score. The higher the difference between the scores the larger the positive value of (Z_{dcc}) indicating a higher 'magnitude of dissociation' in the other direction. Smaller (Z_{dcc}) values close to zero indicated that the phonological score was almost equal to the morphological score hence the 'magnitude of dissociation' is low as the dissociation between the two skills doesn't exist.

A similar analysis was conducted in this section as carried out by Cavalli et al. (2017) in which the magnitude of dissociation was correlated with reading performance. A correlation analysis was carried out between the magnitude of dissociation between the phonological task and the morphological judgement task and reading performance. The (Z_{dcc}) values reported in Table 19 were mostly negative indicating a stronger morphological skill than phonological skill in English. The correlation analysis showed that the magnitude of dissociation between PA and the judgement task was significantly correlated with English nonword reading accuracy $r = 0.57$, $p = 0.01$ and regular word reading accuracy $r = 0.54$, $p = 0.02$. There was no significant correlation with exception word reading $r = 0.42$, $p = 0.07$, but the magnitude of correlation was still large. The correlation analysis also showed that the magnitude of dissociation between PA and the judgement task and nonword reading fluency was significant $r = 0.60$, $p = 0.007$ but not significantly correlated with real word reading fluency $r = 0.28$, $p = 0.24$. A relationship existed between English reading performance and the magnitude of dissociation of linguistic skills (phonological and morphological). The higher the dissociation between the skills, the better the reading performance.

As for the comparison between English PA and the analogy task, the magnitude of dissociation for PA and the analogy task was significantly correlated with nonword reading fluency only $r = 0.49$, $p = 0.01$ and not real word reading fluency $r = 0.12$, $p = 0.61$. Although not significant, the magnitude of the correlation was strongest for nonword reading accuracy $r = 0.42$, $p = 0.07$ and weaker for regular word reading $r = 0.29$, $p = 0.22$ and exception word reading $r = 0.22$, $p = 0.36$.

As for Arabic, for the comparison between PA and the judgement task, the magnitude of dissociation for PA and the judgement task showed no significant correlations to reading performance, and the same was found for the magnitude of dissociation between phonological awareness and the analogy task. A relationship did not exist between Arabic reading performance and the magnitude of dissociation of linguistic skills (phonological and morphological) in line with the fact that very few cases showed a dissociation in Arabic as shown in the previous section's analysis.

Stronger evidence was found in English than in Arabic of a dissociation between phonological and morphological skills where morphological skills were significantly better than phonological skills. The magnitude of dissociation was correlated with the RD children's English reading performance. This suggests that RD children may be using their morphological skills to compensate for their weaknesses in phonological skills while reading. This was not seen in Arabic as weaker evidence of a dissociation between phonological and morphological skills were found. Morphological skills were not significantly better than phonological skills and therefore were not used as a compensatory mechanism while reading. The next section reports the results of the second study in this thesis.

4.3. Study 2

4.3.1. Demographics of participants

This study examined 40 participants in total all of whom had a reading difficulty and were grouped between bilingual (BRD) if they were attending a bilingual school and monolingual (MRD) if they were attending a monolingual school. The participants in the monolingual group were sampled from a government-sponsored private school for children with LD where most of the school instruction takes place in Arabic. These participants were recruited, then their parents signed consent forms, and they all provided a Dyslexia diagnosis or an LD diagnosis from the same assessment centre in Kuwait. The participants were all recruited from the targeted fourth and fifth grades (ages 9 to 11). The bilingual group in this study is the same experimental group from Study 1 where the same procedure was followed: RD children were recruited from two private bilingual schools, then parents signed the consent forms, and then provided a Dyslexia diagnosis or an LD diagnosis from a certified assessment centre in Kuwait. This resulted in 19 participants in the bilingual reading difficulties group (BRD) and 21 participants in the monolingual reading difficulties group (MRD). All the participants in both groups spoke the Kuwaiti dialect at home. Table 15 below summarizes the age, grade, and gender breakdown of the final participants in both the MRD and BRD groups. Chi square tests indicated that there was no significant association between group and gender $\chi2(1, N = 40) = 1.52$, $p = .22$ although overall there were more males than females. Chi square tests also indicated that there was no significant association between group and grade $\chi2(1, N = 40) = 0.12$, $p = .73$. However, there was a significant association between group and age $\chi2(1, N = 40) = 6.81$, $p = .03$ as the BRD group was slightly older.

Table 23. Frequency of age, grade, and gender of participants in the MRD and BRD Groups

Group	Age			Grade		Gender	
	9	*10*	*11*	*4*	*5*	*Female*	*Male*
MRD Group (N = 21)	9 (43.0%)	11 (52.0%)	1 (5.0%)	10 (48.0%)	11 (52.0%)	5 (24.0%)	16 (76.0%)
BRD Group (N = 19)	4 (21.0%)	8 (42.0%)	7 (37.0%)	8 (42.0%)	11 (58.0%)	8 (42.0%)	11 (58.0%)
Total (N = 40)	13 (32.5%)	19 (47.5%)	8 (20.0%)	18 (45.0%)	22 (55.0%)	13 (32.5%)	27 (67.5%)

Note. MRD refers to monolingual children with reading difficulties and BRD refers to bilingual children with reading difficulties. Average age in months for the MRD group is 119 months (*SD* = 7.5) and for the BRD group is 126 months (*SD* = 9.6).

4.3.2. Data Screening

After checking normality of data using histograms, values of skewness and kurtosis, and the Shapiro-Wilk test, control variables such as non-verbal ability, socio-economic status (SES), and receptive vocabulary (Arabic) were normally distributed. Cumulative language exposure (CLE) to Arabic was normally distributed for the bilingual (BRD) group but not the monolingual group (MRD). Using Levene's test to assess for homogeneity of variance, all the scores for the control variables showed no significant difference in variance between the MRD and BRD groups.

Reading accuracy was normally distributed for the monolingual group (MRD) but not the bilingual group (BRD). Reading fluency was not normally distributed for either the MRD or BRD group. As for the Arabic linguistic skills, PA and MA were normally distributed for both groups. RAN was normally distributed for the bilingual group (BRD) but not the monolingual group (MRD). Phonological memory was not normally distributed for both the MRD and BRD group. Using Levene's test to assess for homogeneity of variance, scores for reading accuracy, reading fluency, phonological, and morphological variables showed no significant difference in variance between the MRD and BRD groups. The above data screening measures are summarized and reported in Appendix 8.

As in Study 1, normality issues could not be resolved by transforming the data because scores for some variables were positively skewed in one group and not the other. Transforming the scores for one group might thus induce skew in the other group. Therefore, as the assumptions for using parametric tests were violated, non-parametric tests were used in the following sections to address the analyses for the research questions of this study.

4.3.3. Control Variables

This section reports the descriptive statistics of the control variables (Table 24) as well as the results of the non-parametric tests assessing whether there was any significant difference in the control variables between the two groups (Table 25). The control variables were cumulative language exposure (CLE) to Arabic, receptive vocabulary (Arabic), non-verbal ability, and socio-economic status (SES).

Table 24. Mean scores and standard deviation of the control variables

Measure	MRD Group (n = 21)		BRD Group (n = 19)	
	M	*SD*	*M*	*SD*
Nonverbal ability[1]	49.52	25.58	61.32	25.21
CLE to Arabic	6.87	1.60	4.64	1.95
Receptive Vocabulary (Arabic)[2]	47.52	17.86	28.26	17.68
Socioeconomic Status[3]	2.81	0.56	2.95	0.40

Note. MRD refers to monolingual children with reading difficulties and BRD refers to bilingual children with reading difficulties. Scores on nonverbal ability are standardized percentile scores, vocabulary scores are raw scores, and scores for SES and CLE are reported scores. For SES, a score of 1 = primary education (elementary/middle school), 2 = secondary education (high school), 3 = higher education (Bachelor's degree), and 4 = postgraduate education (Master's/PhD degree). CLE is the sum of the reported language exposure for each year of the child's life with a maximum value of 9 as it was measured up to age 9.
[1] measured using Ravens Progressive Matrices out of 20 items
[2] measured using Peabody Picture Vocabulary Test—Revised (PPVT-R)
[3] calculated as the average of both parents' level of education score

Table 25 below summarizes the results of the non-parametric tests (Mann-Whitney test) assessing whether there were any significant differences in the control variables between the two groups. There were no significant differences between the scores on nonverbal ability and SES between the MRD and BRD groups. There was a significant difference between the scores on CLE to Arabic confirming the expected difference in language exposure between the students attending monolingual and bilingual schools with higher exposure to Arabic for the children attending monolingual schools than bilingual schools. Also, there was a statistically significant difference on receptive vocabulary (Arabic) scores between the two groups with a large effect size (Cohen, 1988b) with a higher Arabic vocabulary score for the children attending monolingual schools than bilingual schools.

Table 25. Results of Mann-Whitney U to Identify Differences between MRD and BRD Groups on Control measures

Measure	MRD	BRD	*U*	*Z*	*p*	*r*
	Mdn	*Mdn*				
Nonverbal Ability	50.00	70.00	147.50	-1.42	.16	-0.22
CLE to Arabic	7.13	4.53	73.50	-3.41	<.001	-0.54
Receptive Vocabulary (Arabic)	52.00	24.00	82.50	-3.17	.002	-0.50
Socioeconomic Status	3.00	3.00	167.00	-0.93	.35	-0.15

Note. MRD refers to monolingual children with reading difficulties and BRD refers to bilingual children with reading difficulties.

4.3.4. Results for research question 1.

Is there a difference in linguistic and reading skills in children with RD who are attending a bilingual school with those attending a monolingual school (is there an advantage for bilingualism in RD children?)

Table 26 shows the means and standard deviations of all scores on Arabic reading and linguistic tasks administered to children with RD attending a monolingual (MRD) and bilingual (BRD) school. A table detailing the scores on the individual reading and morphological tasks is provided in Appendix 11.

Table 26. Summary of descriptive statistics on all Arabic tasks (N = 40)

Measure	MRD Group (n = 21)		BRD Group (n = 19)	
	M	*SD*	*M*	*SD*
Reading Accuracy Composite[1]	0.27	0.85	-0.30	0.85
Reading Fluency Composite[2]	0.17	1.07	-0.19	0.76
Phonological awareness[3]	9.67	4.36	9.37	3.73
Rapid Automatized Naming[4]	47.14	14.77	47.74	21.40
Phonological Memory[5]	9.43	3.33	8.21	3.39
Morphological Awareness Composite[6]	0.06	0.72	-0.07	0.87

Note. Scores on all tasks are raw scores except for reading accuracy, reading fluency, and morphological awareness which are composite scores. MRD refers to children with difficulties attending a monolingual school and BRD refers to children with reading difficulties attending a bilingual school.

[1] average of z scores on three reading tasks (voweled, unvoweled, nonwords) developed and used in Saiegh-Haddad & Taha's (2017) study out of 30 items each

[2] average z scores on two reading tasks real word reading fluency using a list of real words obtained from Tibi (2016) and nonword reading fluency using list of nonwords obtained from the Nonword Reading Accuracy subtest from the Children's Standardized Phonological Processing Test (Arabic)

[3] measured using Elision subtest from the Children's Standardized Phonological Processing Test (Arabic) out of 20 items

[4] measured using Rapid Letter Naming subtest from the Children's Standardized Phonological Processing Test (Arabic)

[5] measured using Nonword repetition subtest from the Children's Standardized Phonological Processing Test (Arabic) out of 20 items

[6] average of z scores from two adapted tasks (judgement and analogy) to measure morphological awareness out of 20 items each

To identify differences between MRD and BRD groups on Arabic measures, a non-parametric independent samples test (Mann-Whitney test) was used. Since the two groups were not matched on age, spearman rho correlations were first carried out and it was ensured that age was not significantly correlated with any of the linguistic and reading variables (correlations table reported in Appendix 12). Most Arabic linguistic and reading scores showed no statistically significant differences between the two groups as seen in Table 27 except for scores on reading accuracy which were higher for the monolingual group than the bilingual group with a small effect size (Cohen, 1988b). This suggests that there was no competitive advantage for bilingualism in children with RD attending bilingual schools compared to children with RD attending monolingual schools. The bilingual and monolingual children performed at the same level on their linguistic skills and reading fluency skills, but the bilingual children were slightly weaker on reading accuracy and considerably weaker on receptive vocabulary.

Table 27. Results of Mann-Whitney U to Identify Differences between MRD (n = 21) and BRD (n = 19) on Arabic measures

Measure	MRD	BRD	*U*	*Z*	*p*	*r*
	Mdn	*Mdn*				
Reading Accuracy Composite	0.26	-0.44	127.00	-1.96	.05	-0.31
Reading Fluency Composite	-0.12	-0.50	154.50	-1.22	.22	-0.19
Phonological Awareness	10.00	10.00	199.50	0.00	1.00	0.00
Rapid Automatized Naming	44.00	41.00	191.50	-0.22	.83	-0.03
Phonological Memory	9.00	9.00	158.00	-1.13	.26	-0.18
Morphological Awareness Composite	0.18	0.08	184.50	-0.41	.68	-0.06

Note. MRD refers to monolingual children with reading difficulties and BRD refers to bilingual children with reading difficulties.

4.4 Summary of results

This research project was divided into two studies. Study 1 examined a group of children with RD attending bilingual schools (n = 19) and a group of age-matched typically developing children (n = 34) attending the fourth and fifth grade. Variables such as nonverbal ability, SES, receptive vocabulary, and past language exposure were controlled for. A Mann-Whitney test showed that the children with RD were compromised in their reading and linguistic skills when compared to the TD group in both English and Arabic. Spearman rho correlations showed that morphological scores were highly associated with reading scores in both English and Arabic with somewhat higher magnitude of correlations for Arabic. Morphological scores were also associated particularly with exception word reading and real word reading fluency in English when phonological processing was controlled for using a non-parametric partial correlations analysis, but this was found in only the TD group and not the RD group. For Arabic, morphological scores were associated with nonword reading accuracy for the TD group and voweled word reading and nonword reading fluency for the RD group when phonological processing was controlled for in the partial correlations analysis. The magnitude of the partial correlations was larger in Arabic for all types of words for the TD group when compared to the partial correlations seen in English highlighting the importance of morphological skills in Arabic reading.

A single case analysis was carried out and the 19 children with RD were examined separately to identify their profiles in more detail. Their phonological and morphological scores were examined in both English and Arabic and most of the cases showed a deficit on their phonological and morphological scores compared to the TD group while a minority showed no deficit in either skill. In English, six cases showed significantly better morphological scores on both the morphological tasks administered compared to phonological scores and this difference was much higher than the difference seen in the control group which could indicate a dissociation between these two skills in these children. In Arabic, these results were not found as only a minority of cases showed significantly better morphological scores than phonological scores, and this was only on one of the morphological tasks administered. A correlation analysis was carried out to examine the association between the effect size of the difference between the phonological and morphological scores also known as the ‘magnitude of dissociation’ in the children with RD and its relationship with their reading performance. Results showed that the magnitude of dissociation was related to their reading performance in English, the higher the dissociation between the scores, the better their reading performance. This was not found in Arabic as very few cases showed a dissociation between the two skills.

Finally, Study 2 examined the same group of children with RD (n = 19) attending bilingual schools and compared them to a group of children with RD (n = 21) attending monolingual schools. Variables such as nonverbal ability and SES were controlled for. Arabic receptive vocabulary scores were much higher for the group attending monolingual schools than for the group attending bilingual schools. Past language exposure showed that the group attending monolingual schools were exposed to Arabic to a higher extent than the children attending bilingual schools, as expected. A Mann-Whitney test showed that there were no differences in reading and linguistic scores between the RD children attending bilingual schools compared to those attending monolingual schools except for their scores on reading accuracy in which the group attending monolingual schools scored higher and the difference was a small effect. These results will be discussed in more detail in the next chapter.

5. Discussion

5.1 Introduction

Understanding the cognitive mechanisms that underlie skilled and atypical reading development in bilingual children is crucial to researchers and educators. The current research had three main aims. The first aim was to explore the role of MA in typical readers and children with RD within each language (English and Arabic) among children attending bilingual schools and to understand whether previous research (relating to morphology and reading) conducted with monolingual children can also be applied to bilingual children. The second aim was to examine children with RD on a single-case basis to identify their individual profiles, whether their phonological and morphological skills dissociate, and whether their morphological skills may compensate for weaknesses in phonological skills while reading. The third and final aim was to examine the influence of bilingual and monolingual education on linguistic skills and reading skills of children with RD. This was accomplished in a set of two studies. Study 1 included 53 participants who were divided into typically developing children (TD group, n = 34) and children with reading difficulties (RD group, n = 19) all of whom were attending a bilingual school, and this study addressed the first two aims of the thesis. Study 2 included 40 participants who included the same children with RD attending bilingual schools (the BRD group, n = 19) and a group of children with RD attending a monolingual school (MRD group, n = 21), and this study addressed the third aim of this thesis. This chapter will be organized around sections addressing the aims of the current study, which include discussions of the results of the research questions of the current study considering previous research and theories. This is followed by the limitations and challenges faced during COVID.

5.2. TD children vs children with RD

The first research question in Study 1 was, "*Are linguistic skills and reading skills compromised in children with reading difficulties compared to the age-matched controls all of whom are attending a bilingual school?"* The children with RD were compromised on almost all Arabic and English skills when compared to controls who were matched on age, gender, grade, nonverbal ability, SES, and past language exposure to English and Arabic. They were compromised on English and Arabic phonological processing skills (except for Arabic RAN skills), MA, and reading skills. Results were as expected and in line with previous studies in different orthographies that have found compromised skills among monolingual children with RD compared to age-matched TD children (Abu-Rabia & Siegel, 2003; Constantinidou & Stainthorp, 2009; Jiménez et al., 2009). The results lend support to the central processing hypothesis (Bialystok & Ryan, 1985; Geva & Ryan, 1993; McLaughlin et al., 1983) that states that children with poor cognitive and linguistic skills will face problems in reading regardless of the orthography or type of language script (though see section 2.6.5. for a notable exception). As mentioned above, children with RD were highly compromised in their phonological awareness skills with a large effect size (r = 0.7) compared to controls, in both Arabic and English. This is in line with previous research involving both English and Arabic-speaking monolingual children with RD where weaknesses in phonological processing was thought to be the main cause of word reading difficulties in both English (Snowling, 1980, 2013; Stanovich & Siegel, 1994; Vellutino et al., 2004; Vellutino & Scanlon, 1987; Wagner & Torgesen, 1987) and Arabic (Abu-Rabia et al., 2003; Elbeheri & Everatt, 2007; Layes et al., 2015; Mannai & Everatt, 2005; Saiegh-Haddad & Taha, 2017; Smythe et al., 2008).

As mentioned above, children with RD in the current study showed deficits in their morphological skills when compared to controls. This is in line with studies examining monolinguals where children with RD have shown deficits in MA among English-speaking students (Carroll & Breadmore, 2018; Elbro, 1990; Siegel, 2008; Tsesmeli & Seymour, 2006) and among Arabic-speaking students (Abu-Rabia, 2007; Abu-Rabia et al., 2003; Layes et al., 2017; Saiegh-Haddad & Taha, 2017). The reason put forward for this, explained in section 2.6.4., is that children with RD have lower exposure to text than TD children and therefore their orthographic and morphological skills do not accumulate at a similar rate (Georgiou et al., 2022). However, the students with RD in this study showed larger morphological deficits in Arabic, relative to controls, as seen from the larger effect size in Arabic (r = 0.65) than in English (r = 0.5). This provides support for the script-dependant hypothesis (Geva & Siegel, 2000; Gholamain & Geva, 1999), which states that since orthographies are different, then this leads to different patterns of RD in these orthographies. This is in line with results from a study examining bilingual English-Arabic children of similar age group who performed worse on the Arabic morphological decomposition task than the English morphological tasks (Saiegh-Haddad & Geva, 2008). This could be due to the more complex non-linear derivational process in Arabic (Saiegh-Haddad & Geva, 2008). Therefore, since MA is more complex in Arabic than in English, then this could be the reason why MA was more compromised in Arabic than in English in the children with RD in the current study. Having said that, this thesis examines within-language associations only and does not examine cross-linguistic associations. That is because to examine cross-linguistic associations, equivalence across the two languages in task difficulty is important (Koda, 1994), see Section 6.3. The judgement tasks in both English and Arabic required the child to choose whether the word came from the same root or not, but given the different morphological structure in each language, the "root" in English does not mean the same thing in Arabic given that it is an abstract concept in Arabic (Saiegh-Haddad & Henkin-Roitfarb, 2014), see section 2.4.3. Also, the written analogy task in English contained fully connected words while the Arabic written analogy task contained unconnected letters to represent the root as was adapted from the standardized Orthographic Processing and Morphological Awareness Test (Mahfoudhi et al., 2012). Therefore, since ensuring task equivalence was very difficult, the current research examined within-language associations only and did not examine cross-linguistic associations. This means that although MA was more compromised in Arabic than in English in the children with RD in the current study, this does not necessarily mean that they are better in MA in English compared to Arabic rather that the differences in scores between the two languages could be due to the different skills required to tackle the tasks in the two languages.

As mentioned above, Arabic RAN scores were not significantly compromised compared to controls and this could be due to the high variability in the Arabic RAN scores. Letter knowledge in Arabic-speaking children has been argued to be influenced by many factors such as how frequent the letter is (Boudelaa et al., 2020), whether the phoneme develops at an early, intermediate or later age (Amayreh, 2003), and diglossia (Tibi et al., 2022). However, no previous studies have examined whether these factors influence bilingual children in the same way or whether additional factors such as whether the phoneme exists in Arabic but not English would influence letter knowledge. It seems from the findings that since RAN scores were not compromised in Arabic and were compromised in English, then this could imply that RAN scores were better in Arabic than in English. This is in contrast to previous research that has argued that Arabic letters are more complex than English letters (Verhoeven & Perfetti, 2022), see section 2.3.5. The findings could also mean that because the control children had high variability in the scores and didn't all perform well on the RAN task in Arabic, then this could explain why children with RD's scores were not significantly lower than the controls. Again, this could be because Arabic letters are more complex than English letters (Verhoeven & Perfetti, 2022). Twelve Arabic letters were included in the letter naming task of which most of the letters were ranked frequent (Boudelaa et al., 2020) but two letters were ranked as low frequency letters (ه , ز), which has been argued to influence letter knowledge: the more frequent a letter is, the easier it is to identify (Tibi et al., 2022). Most of the letters represented early and intermediate developing phonemes (develop before age 6) while 3 letters (ع , ط , ز) represented phonemes that develop at a later age (between age 6 to 8), which influences letter identification, the later the letter develops the harder it is to identify it (Tibi et al., 2022). One of the letters (ك) represented a diglossic phoneme (Tibi et al., 2022). Previous research has argued that diglossia slows down letter naming (Asaad & Eviatar, 2013). As the RAN task contained psychometric properties relating to monolingual children, then this could explain the high variability in the RAN scores in the bilingual children. Again and as mentioned above, this thesis examines within-language associations only due to lack of task equivalence. It is difficult to say whether the children with RD had stronger naming deficits in English than Arabic. The English letter naming task is not completely equivalent to the Arabic letter naming task where in the English task there were 6 recurring letters while in the Arabic task there were 12 recurring letters).

When the children with RD were compared to the TD children in Study 1, variables such as nonverbal ability, SES, receptive vocabulary and past language exposure needed to be controlled for as previous studies have shown their influence on reading skills (Abu-Rabia et al., 2003; Cunningham & Stanovich, 1990; Mannai & Everatt, 2005; Paradis, 2010; Yando et al., 1979). However, results showed that the children with RD scored significantly lower than controls on English receptive vocabulary and their Arabic receptive vocabulary scores were also much lower than controls. This is in line with previous descriptions of children with RD in which having a reading difficulty reduces exposure to text and therefore this may influence their vocabulary growth (Share & Silva, 1987; Snowling & Melby-Lervåg, 2016). It is for this reason that receptive vocabulary was controlled for when conducting analyses including both TD and RD children.

5.3. MA and reading among TD children

The second research question in Study 1 was, "*Is morphological awareness (MA) more strongly related to reading in Arabic than in English?*" MA was highly correlated with both reading accuracy and fluency in English and the same was observed for Arabic, with the magnitude of correlations between MA and reading appearing somewhat higher for Arabic than English. The findings are consistent with Arabic and English monolingual reading literature where studies have shown associations between MA and English word reading accuracy and fluency (Kirby et al., 2012; Levesque et al., 2017; Nagy et al., 2006; Singson et al., 2000) and to Arabic word reading accuracy (Abu-Ahmed et al., 2014; Abu-Rabia, 2007; Saiegh-Haddad & Taha, 2017; Tibi, 2016; Tibi et al., 2020; Tibi & Kirby, 2017, 2019) and word reading fluency (Asadi et al., 2017; Schiff & Saiegh-Haddad, 2018). However, a large amount of variance remained unexplained in this analysis as it was a simple correlation analysis that does not control for additional variables related to reading. That is why the relationship between MA and Arabic and English reading was investigated further in the next section. Further variables were controlled for, such as phonological processing and receptive vocabulary, to account for the unexplained variance. The relationship between MA and children's reading of different word types in each language was also examined: nonwords, regular words, exception words, voweled words, unvoweled words).

The main aim of third research question was to further explore the relationships between MA and reading within both languages. The third research question in study 1 was divided into three subparts a) "*Is morphological awareness (MA) associated with reading accuracy and fluency levels over and above that of phonological processing within each language? Does the relationship differ depending on the reading task (accuracy/fluency)?" b) "Within reading accuracy and fluency, does the relationship between morphological awareness and reading differ depending on the type of word (English: nonword/regular/exception; Arabic:nonword/ voweled/unvoweled) within each language?" c) "Within reading accuracy and fluency, does the relationship between morphological awareness and reading differ depending on the type of word (English: nonword/regular/exception; Arabic: nonword/voweled/unvoweled) within each language in each of the two groups (TD and RD) whilst controlling for phonological processing?"* Question 3A involved the entire bilingual sample (TD and RD children) to add power to the analysis by using a larger sample size. However, since receptive vocabulary scores (both English and Arabic) were much lower for RD students compared to TD students, then receptive vocabulary needed to be controlled for. Results showed that, after controlling for phonological processing and receptive vocabulary, there was no significant association between MA and reading accuracy and fluency in English, but there was still a strong association between MA and reading accuracy and fluency in Arabic. This is in contrast to the previous English monolingual studies examining children of a similar age group, which have shown associations between MA and reading accuracy and fluency whilst controlling for phonological processing and receptive vocabulary (Kirby et al., 2012; Levesque et al., 2017;

Nagy et al., 2006; Singson et al., 2000). The reason why the current study's findings might be inconsistent with previous findings is that the analysis of the first subpart of this research question included associations between MA and reading accuracy and fluency composites, which were averages of regular word, exception word and nonword accuracy, and of nonword and word reading fluency, respectively. While in the previous English monolingual studies, different word types (real words and nonwords) were analysed separately, and this could be the reason for the contrasting results. Therefore, in research question 3B, the associations between MA and different types of words (nonwords and real words) were analysed, again within the entire bilingual sample.

Results for research question 3B again showed no associations between MA and all types of English word reading accuracy (nonword, regular, and exception word reading) and fluency (nonword and real word reading) whilst controlling for phonological processing and receptive vocabulary, but there was still a significant association between MA and all types of Arabic word reading accuracy (nonword, voweled, and unvoweled reading) and fluency (nonword and real word reading). Again, this contrasts with findings seen in previous English monolingual studies examining children of similar age group (Kirby et al., 2012; Levesque et al., 2017; Nagy et al., 2006; Singson et al., 2000). However, these previous studies examined TD children only and did not include children with RD in their analyses. Therefore, research question 3C analysed the associations between MA and different types of reading within the TD and RD groups separately. However, due to the small sample size and low statistical power, these results should be interpreted with caution.

Results for research question 3C showed that, for the TD group, there was a significant association between MA and English exception word reading over and above that of phonological processing. MA was not significantly associated with nonword or regular word reading. This suggests that TD children were strategically making use of MA to read exception words, which couldn't be decoded accurately through phonological recoding. This is in line with Nagy et al.'s (2006) study who found MA to be associated more with morphologically complex words that contained irregular stems as opposed to words that were phonologically transparent in monolingual children the same age. The results are also consistent with the Morphological Pathways framework (MPF) (Levesque et al., 2021), which argues that MA is associated with decoding words in English-speaking children. Since the association was only for exception words and not for regular words or nonwords, the findings also lend support to Rastle's (2019) hypothesis that MA is an important part of reading development especially within the ventral reading pathway (see section 2.4.5.2), where this pathway works better for exception words that can't be accessed by mapping spelling to sound (Coltheart et al., 2001; Taylor et al., 2013).

As for English reading fluency, after controlling for phonological processing, MA was not significantly associated with real word/nonword reading fluency in the TD group. The results are in contrast with previous research on English monolingual students between the age of 6 to 8 where MA was associated with reading rate (Kirby et al., 2012). It is unexpected that the current study's results relating to the association between MA and real reading fluency were not significant since both the current study and Kirby et al.'s (2012) study administered the same reading fluency task, a very similar morphological analogy task, and the current study sample is an older age group. However, the analogy task in the current study included items focusing on only derivational morphology while the analogy task in Kirby et al's (2012) study included analogy of items using inflectional and derivational morphology. In addition to that, the current study presented the analogy items in both the oral and written format while in Kirby et al's (2012) study they were only presented in the oral modality. Nonverbal ability was controlled for in Kirby et al's (2012) study while the current study did not control for nonverbal ability. Although the results did not reach significance, the magnitude of correlation of 0.35 between MA and real reading fluency indicated that MA accounted for a medium amount of variance in real reading fluency, which is comparable with the strength of the relationship reported in Kirby et al.'s (2012) study suggesting that the current study was underpowered due to sample size. Another study has shown that MA was associated with reading fluency in monolingual children that were older than the current sample (eighth and ninth grade), and argued that MA was associated with reading accuracy for younger grade levels, similar to the current study (fourth and fifth grade), and associated with reading fluency for older grade levels (Nagy et al., 2006). Therefore, studies with older age groups of biliterate students would show whether MA and reading fluency are associated in older grade levels. However, it is important to note that although Nagy et al.'s (2006) study used a similar morphological judgement task to the current study, they used a very different task to measure the rate of reading morphologically complex sets of words. Overall, the MPF and Rastle's (2019) hypothesis were both based on monolingual readers, and it seems that they can also be applied to the bilingual readers in the current study for reading accuracy but not reading fluency. The next section discusses the role MA played in reading Arabic words within the biliterate population of the current study.

5.4. MA and Arabic reading among TD children

As for the Arabic results for research question 3C *"Within reading accuracy and fluency, does the relationship between morphological knowledge and reading differ depending on the type of word (nonword/voweled/unvoweled) within each language in each of the two groups (TD and RD) whilst controlling for phonological processing?"*, there was a significant relationship between MA and nonword reading in the TD group, after controlling for phonological processing. This is in line with a previous Arabic monolingual study that has found that MA was linked to nonword reading accuracy among 8–9-year-old students after controlling for phonological awareness (Tibi & Kirby, 2019). The association between MA and nonword reading has also been observed in other languages such as studies examining English monolingual students of similar age group (Deacon & Kirby, 2004; Kirby et al., 2012). Deacon and Kirby (2004) argue that it is counterintuitive that MA is associated with nonwords that don't have meaning, but the reason for this association could be that sometimes nonwords contain real morphemes embedded in nonwords such as the *hop* in *hopdalhup.* Therefore, children may use these morpheme boundaries to decode nonwords. This logic can also be applied to Arabic nonwords in the sense that Arabic nonwords are comprised of roots that do not have meaning but are embedded within commonly used word patterns. For example, the nonword (صارِشْ) follows the agentive word pattern (Ca:CeC), see section 2.4.3. The word-pattern provides a word's categorical meaning and phonological form (Saiegh-Haddad & Henkin-Roitfarb, 2014). Since, in this case, the meaning doesn't make sense, then the transparent morphemic structure of the word pattern is still providing a phonological form for children to follow to decode words. Kuo and Anderson (2006) suggest that the association between MA and nonwords could be due to general metalinguistic awareness skills involved in word reading. For example, Carlisle and Kearns (2017) stated that although MA explained unique variance in nonword reading in the students in Kirby et al.'s (2012) study, the majority of the variance was shared between several linguistic skills: phonological, morphological, and orthographic. This echoes the concept that MA is multidimensional (see section 2.4.5.) and is divided between the linguistic system, orthographic system, and lexical representations (Levesque et al., 2021). As Levesque et al. (2021) stated, more research is warranted to explore the reason for the associations between MA and nonword reading.

Continuing the Arabic results for research question 3C, MA was not significantly associated with voweled and unvoweled word reading for the TD group. This is in contrast with previous Arabic monolingual studies that have found that MA was linked to voweled (Tibi & Kirby, 2019) and unvoweled (Saiegh-Haddad & Taha, 2017) word reading accuracy in children of slightly younger age group. However, the magnitude of correlations in the current study was close to 0.3 for both voweled and unvoweled reading accuracy. Although not significant, MA still accounted for a medium amount of variance when reading voweled and unvoweled words, which is comparable with the strength of the relationship reported in Saiegh-Haddad and Taha's (2017) study and Tibi and Kirby's (2019) study suggesting that the current study was underpowered due to sample size. In Saiegh-Haddad and Taha's (2017) study, which examined Arabic monolingual children ranging in age from 6-9 years old, MA accounted for most of the variance in unvoweled words followed by voweled words and no significant variance in nonwords in the older readers. The opposite results were seen in the bilingual TD children in this study where MA accounted for most of the variance in nonwords followed by voweled words and unvoweled words equally. It seems the bilingual children were still relying to a greater extent on their phonological rather than morphological decoding skills at age 9-11 years old when reading voweled and unvoweled words. One of the reasons could be due to the different tasks that were used to measure MA in the two studies. Another reason could be perhaps the bilingual readers in the current study who have had less exposure to Arabic compared to the monolinguals in Saiegh-Haddad and Taha's (2017) study require more time to consolidate their letter-based (consonants and long vowels) morpho-orthographic processes to be able to utilize them more when reading unvoweled words (Saiegh-Haddad, 2018), see section 2.4.6. This could only be corroborated if this study was a cross-sectional study examining bilingual readers of different age groups, which a future study should explore. The same was also argued in a study examining biliterate Chinese-English students in Singapore of the same age in which the students whose home language was English relied more on morphological decoding in English reading than the group whose home language was Chinese arguing that perhaps the process of using morphological decoding while reading in biliterate children whose home language is not English is delayed compared to English monolingual children (Zhang & Ke, 2020). The reason home language exposure might influence decoding strategies was argued to be because it may influence the development morphological representations in memory and therefore students with more exposure have stronger lexical quality (Perfetti, 2007) than students who are less exposed (Zhang & Ke, 2020). Another study including English-French students in immersion schools in Canada who were examined at age 6 and then at age 8 also argued that the reason behind the increasing contribution of MA to French reading and not

English reading that was evident across the years could be due to higher exposure to French reading and writing in school (Deacon et al., 2007). Therefore, students may use morphological skills to a larger extent in the language that they read and write in most (Deacon et al., 2007). These arguments may also be applied to the biliterate students in the current study where exposure to Arabic in the home is lower than that of monolinguals, see section 4.3.3., and English is the medium of instruction in their schooling, see section 3.5., and so they may utilize MA in Arabic reading to a lesser extent than monolinguals. This is in line with McBride and Mohseni's (2023) argument that language exposure may influence biliteracy and student's reading strategies and what type of decoding they rely on.

The Arabic reading fluency results showed no significant associations between MA and nonword and real word reading fluency in the TD group, but the magnitude of corelations of 0.2 indicate that MA explains a small amount of variance in both nonword and real word reading fluency. A larger and significant amount of variance was explained by MA for Arabic reading fluency measures in previous studies examining Arabic monolingual 8-9 year old children (Tibi & Kirby, 2019) and bilingual English-Arabic children ranging in age from 6-9 years old (Saiegh-Haddad & Geva, 2008). Again, the reasons for the different results could be due to the small sample size and low statistical power as the earlier analyses that included the entire sample showed otherwise.

Models such as the Model of Arabic Word Reading in Development (MAWRID) model (Saiegh-Haddad, 2018), see section 2.4.6., which argues that the reader uses two decoding mechanisms at the same time with different linguistic units as grain sizes: a grapheme-based (letters and diacritics) phonological one and a letter-based (consonants and long vowels) morpho-orthographic one in older and skilled readers (Saiegh-Haddad, 2018; Saiegh-Haddad & Schiff, 2016; Ziegler & Goswami, 2005) does not seem to apply to the biliterate sample in the current study. The results did not show a significant association between MA and unvoweled reading, but only a medium amount of variance. More research is needed examining a larger sample of biliterate students of different age groups to understand the role of MA in Arabic reading in bilingual children and whether previous models based on monolinguals applies to them or whether they show different patterns of reading due to cross-linguistic transfer (Cummins, 1979) or language exposure (McBride & Mohseni, 2023).

5.5. MA and English vs Arabic reading among TD children

For Arabic, MA explained an almost equal amount of variance for reading across all word types for both reading accuracy and fluency, while in English, MA only explained variance when reading exception words and real word fluency. It seems that TD children attending bilingual schools utilize MA while reading in Arabic across all word types while MA is more associated with reading in certain types of words in English. Compared to previous monolingual English studies (Nagy et al., 2006), MA was also associated with more morphologically complex words than phonological transparent ones, and overall similar amount of variance was explained by MA in the current study. However, overall MA explained a lower amount of variance in reading, especially for voweled and unvoweled words, among the biliterate TD sample in the current study compared to Arabic-speaking monolinguals in previous studies (Abu-Ahmed et al., 2014; Abu-Rabia, 2007; Saiegh-Haddad & Taha, 2017; Tibi, 2016; Tibi & Kirby, 2017). As very few previous studies have focused on examining bilingual children and the role of MA in reading, further research is warranted to understand the role of MA in reading in both languages among students attending bilingual schools. The importance of PA versus MA in Arabic word reading is still not yet well understood in monolinguals (Saiegh-Haddad, 2017) and needs to be explored further as it may vary as a function of the type of script (voweled/unvoweled) and reading task (fluency/accuracy). The same can be said for English where more models should incorporate the role of MA in reading development (Carlisle, 2010; Kuo & Anderson, 2006) as the MPF (Levesque et al., 2021) is the only theoretical model to attempt to precisely do so.

5.6. MA and reading among children with RD

As for the children with RD, no associations were found between MA and English reading accuracy and fluency (all word types). There are very few studies examining morphological skills among English monolingual children with RD to compare these results with. However, a review of intervention studies targeting morphological instruction has shown that morphological instruction resulted in moderate effects on word decoding (Goodwin & Ahn, 2013). However, the review highlights that to maximise the benefit of morphological instruction, there needs to be more understanding of when and how morphemes impact literacy to be able to design the intervention. A recent study reported improvements in some reading skills as a result of an intervention targeting morphological skills delivered to English-speaking monolingual children with poor reading skills of a similar age group (Georgiou et al., 2021). This suggests that children with RD can benefit from instruction focused on both morphological and phonological skills to improve their reading skills whereas the focus of most of the previous intervention studies has been on remediation of phonological skills only as highlighted in Galuschla et al.'s (2014) review. Therefore, it was surprising that there was no evidence of an association between MA and reading for the children with RD. Again, this could be due to the small sample size and low statistical power.

The Arabic results showed that MA was significantly associated with voweled word reading among the children with RD, after controlling for phonological processing, but was not significantly associated with nonword reading and unvoweled word reading. This is in line with previous Arabic monolingual studies which have found associations between MA and voweled word reading among children with dyslexia that are of a slightly older age group (13 years old) and children that have been identified as poor decoders that are of a slightly younger age group (8 years old), suggesting that these children may have been relying on their morphological skills to compensate for weaknesses in phonological skills while reading voweled words (Abu-Rabia & Abu-Rahmoun, 2012; Tibi & Kirby, 2019). However, the opposite pattern was found with previous Arabic monolingual studies which have found associations between MA and unvoweled word reading in children with RD ranging in age from 6-9 years old and did not find associations between MA and voweled reading (Saiegh-Haddad & Taha, 2017). Although MA was not significantly associated with unvoweled reading in the RD group in the current study, the magnitude of correlation was 0.3 indicating that MK explained a medium amount of variance in unvoweled reading. The results did not reach significance probably due to the small sample size and low statistical power. Another possible reason could be, as mentioned in section 2.6.3, that because children with RD face problems with phonologically recoding voweled words this influences their store of orthographic representations and morphemes in memory (Schiff & Saiegh-Haddad, 2017; Share, 2008b). Therefore, they use morpho-orthographic processes to a lesser extent when decoding unvoweled words (Saiegh-Haddad, 2018; Schiff & Saiegh-Haddad, 2017). This argument was based on a study examining a group of 11-year-old children with RD in Israel who found no differences between reading accuracy for voweled words and unvoweled words while unvoweled words were read more accurately than voweled words in 11 year old TD children due to the increased reliance on morpho-orthographic processes while reading (Saiegh-Haddad, 2018; Schiff & Saiegh-Haddad, 2017). In fact, a similar pattern was seen in the current study where additional analyses reported in Appendix 13 showed no differences between reading accuracy of voweled and unvoweled words for the children with RD while TD children read unvoweled words more accurately than voweled words. According to Gregory et al.'s (2021) argument, perhaps children should make the switch to unvoweled reading according to their strengths and weaknesses and not according to a certain age cut-off.

Overall, the use of MA was not seen in the children with RD when reading English words. As for Arabic, the use of MA while reading voweled words among children with RD seems to be related to weaknesses in their phonological skills and possible use of MA skills as a compensatory mechanism. It does not seem like biliterate children with RD are using MA as a morpho-orthographic strategy to read unvoweled words that was seen in monolingual children with RD in a previous study (Saiegh-Haddad & Taha, 2017). As for reading fluency, there was a significant association between MA and nonword reading fluency in the RD group and no association between MA and real word reading fluency in the current study. This could be due to the children with RD using their morphological skills to compensate for weaknesses in their phonological skills as nonword reading requires a lot of phonological recoding especially under timed conditions. This has been seen in monolingual Arabic-speaking students with RD ranging in age from 6-9 years old where MA accounted for variance in nonword reading accuracy suggesting the use of morphological skills as compensatory strategy (Saiegh-Haddad & Taha, 2017). Further research is needed with larger samples and different age groups of biliterate children with RD to understand further the role MA plays in biliterate children with RD. The next section discusses the profiles of the children with RD on a single-case basis and examines the compensatory strategy in more detail.

5.7. Single case profiles, dissociations, and correlations to reading

The fourth research question in Study 1 was split into two parts: a) "*Upon examining the profile of children with reading difficulties individually: do they show a deficit in phonological awareness, morphological knowledge, both, or neither in each language? Is there a dissociation between PA and MA?*" and b) "*Is there a relationship between the magnitude of dissociations and reading performance in children with reading difficulties? Are they using their morphological skills to compensate for the weakness in their phonological skills?*" Results for the first part of the research question showed that most of the cases showed a deficit in their phonological skills and morphological skills in both English and Arabic and a minority showed no deficit on both skills. Evidence of the dissociation between the phonological and morphological skill, where a phonological deficit is present in the absence of a morphological deficit, could mean that children with RD may use morphological skills to compensate for their weaknesses in phonological skills. There was more evidence of a dissociation between phonological and morphological skills in English than in Arabic. For English, children either had a phonological deficit in the absence of a morphological deficit or had a much larger phonological deficit than a morphological deficit. This provided support for the hypothesis that students with RD may use MA while reading to compensate for their phonological deficits (Cavalli et al., 2017; Elbro & Arnbak, 1996; Saiegh-Haddad & Taha, 2017). This was not seen in Arabic as weaker evidence of a dissociation between phonological and morphological skills was found. Morphological skills were not significantly better than phonological skills in Arabic. Some cases had similar degrees of deficits in phonological and morphological skills while other cases' morphological skills were slightly better than phonological skills. The MA skills were simply not strong enough in Arabic to meet the criteria for a dissociation. This could be due to the more complex derivational process in Arabic, which is non-linear as opposed to the less complex linear morphological derivational structure in English. Also, as mentioned in section 5.4., the children were more exposed to English reading than Arabic reading and therefore language exposure could have influenced their morphological skills (Deacon et al., 2007). As seen in the results of the first research question, see section 4.2.4., students in the RD group performed better on the English morphological tasks than the Arabic morphological tasks. Students in the RD group found the analogy tasks particularly more difficult in Arabic than in English as their scores were showing near floor effects. A review of studies examining MA deficits in children with RD including both English and Arabic studies has shown that analogy tasks tend to be more difficult for children with RD as they also require additional analysis (Georgiou et al., 2022). Future studies should explore the dissociation between morphological skills and phonological skills among students with RD in Arabic using different tasks as well as in older age groups to understand the nature of these skills further.

There are no previous studies that have examined RD children's phonological and morphological skills in English and Arabic on a single case basis to compare the results of the current study with. However, the findings replicate that of an earlier study conducted in a different sample of French-speaking dyslexic university students who showed a dissociation between phonological and morphological abilities (Cavalli et al., 2017). They all showed a phonological deficit in the absence of a morphological deficit. The current study's cases show much lower instances of a dissociation and that could be due to the different languages examined, the different levels of morphological complexity, and the difference in age. Cavalli et al.'s (2017) study sample was monolingual French-speaking university students and current study sample examined Arabic-English bilingual children. The difference in age is an important factor because the importance of PA and its relationship to word reading starts to decrease after the first few years of reading in typically-developing English-speaking children while the relationship between MA and reading starts to increase (Nagy et al., 2006). The French-speaking university students have had many more years to develop MA and compensatory strategies. The development of morphological skills in children with RD has been argued to be slower than TD children due to less exposure to text influencing the development of orthographic representations and morphemes (Georgiou et al., 2022). Therefore, the dissociation between phonological and morphological skills would need to be examined using single case analysis among children with RD across among older age groups to explore whether dissociations are evident.

Results for the second part of the research question showed that the magnitude of dissociation was correlated with English reading performance in the children with RD. Correlations were significant for nonword and regular word reading accuracy as well as nonword reading fluency where the need for phonological recoding is high. The results are in line with the results found for the French-speaking dyslexic university students in Cavalli et al.'s (2017) study where the degree of dissociation was positively correlated with their reading skills suggesting that individuals with RD may be using their morphological skills to compensate for their weaknesses in phonological skills while reading. This was not seen in Arabic as weaker evidence of a dissociation between phonological and morphological skills was found and so no evidence was found of a correlation between magnitude of dissociation and reading. Cavalli et al. (2017) argued that cases with low phonological awareness skills need to have very strong MA skills to be able to use them to compensate when reading. This reasoning may be applied to the Arabic cases where morphological skills were not strong enough to meet the criteria for a dissociation and therefore may not have been utilized to compensate for reading. The next section compares these results with the results of the group analyses performed.

5.8. Single case analysis vs group analysis

In this section, the group results for Study 1 (comparing bilingual children with and without dyslexia) and the single-case results will be discussed simultaneously to analyse whether they complement each other or not. According to the group analysis, no associations were found between MA and English reading accuracy and fluency (all word types). However, looking at the single-case analysis results, there was evidence of a dissociation between phonological and morphological skills in English in six cases where these cases showed a phonological deficit in the absence of a morphological deficit, and the size of this dissociation was correlated with the RD children's nonword and regular reading accuracy as well as nonword reading fluency. As a group, it seemed that students with RD were not making use of their morphological skills while reading, according to the group analysis, but when the RD students were examined one by one, it was apparent that some of these RD students may use MA while reading to compensate for their phonological deficits as seen in previous studies (Cavalli et al., 2017; Elbro & Arnbak, 1996; Saiegh-Haddad & Taha, 2017). This is why it is important to be cautious about group analyses involving students with RD because they are heterogeneous, which implies that educators need to plan children's interventions tailored to the specific strengths and weaknesses of the child (Reid, 2016).

As for the Arabic results for the children with RD, MA explained significant variance for voweled word reading accuracy as well as nonword reading fluency. This suggests that the children with RD may have resorted to their morphological skills to compensate for their weakness in phonological skills in this certain task as reading voweled words depends heavily on the use of phonological recoding. Saiegh-Haddad and Geva (2008) argued in relation to their study examining TD English-Arabic bilinguals of a similar age group that the linguistic skills (phonological vs morphological) that were associated with reading accuracy of untimed tasks were different than the skills associated with a timed reading fluency task. When the children were given a voweled and nonword reading accuracy task, PA was the only significant predictor of reading. However, when the children were given a derived word reading fluency task, MA was a significant predictor of reading even when PA was entered first in the regression analysis. Therefore, perhaps the timed nature of the nonword fluency task impacted the current study's RD children's processing strategy and they resorted to using morphological skills to compensate for weaknesses in phonological skills. Looking at the single-case analysis, there was no evidence of a dissociation between phonological and morphological skills in Arabic. In this case, one must also be cautious of single-case analyses as they are not perfect either and results are highly dependent on the individual tasks used for the analyses. The students with RD found the analogy tasks to be particularly difficult in Arabic. It may be for this reason that no dissociation was found between phonological and morphological skills. Perhaps in Arabic, PA and MA skills are more related than in English (see correlation tables 11 and 12), and don't necessarily dissociate, but the children with RD were using MA skills as a compensatory strategy in the group analysis because of the task demands. Again, more research is warranted to understand the role of MA in children with RD in both Arabic and English using both group and single case analyses.

5.9. The English vs Arabic Orthography

Looking at the correlations between all the variables in the bilingual sample (Tables 11 and 12), it was apparent that PA was highly correlated to reading accuracy more so in Arabic (combination of voweled and unvoweled words) than English, while RAN was more strongly correlated with reading fluency in English than Arabic. This is not consistent with the argument mentioned in Section 2.3.2 relating to the extent to which PA is less related to reading in consistent orthographies (Georgiou et al., 2008; Liberman et al., 1980; Ziegler & Goswami, 2005). In voweled Arabic, PA has been found to be a strong predictor of reading despite the consistent relationship between spelling and sounds in this orthography (Abu-Ahmed et al., 2014; Mannai & Everatt, 2005; Smythe et al., 2008; Taibah & Haynes, 2011; Tibi & Kirby, 2018). The results of the current research provide support for Daniels and Share's (2018) argument that earlier conclusions and hypotheses that were developed based on research examining European alphabetic orthographies focusing on the concept of spelling-sound consistency only do not apply to an orthography like Arabic. The Arabic orthography contains additional dimensions (missing vowels, visual similarity of letters, ligaturing, different forms of letters depending on position in word, letters that represent both consonants and vowels, diglossia), as discussed in full in Section 2.3.6. Therefore, it was not surprising that PA was more highly correlated to reading accuracy in Arabic than English. As mentioned in Section 2.3.3., naming speed, on the other hand, showed conflicting results in the literature relating to whether it was more related to reading in consistent/inconsistent orthographies (Georgiou et al., 2008; Kirby et al., 2010; Landerl & Wimmer, 2008; Moll et al., 2014). In the current study, RAN was more strongly correlated with reading fluency in English than Arabic. Both English and Arabic are considered to be deep orthographies, and RAN has been shown to be related to reading universally regardless of orthographic depth (Landerl et al., 2022).

5.10. Children with RD attending bilingual vs monolingual schools

It has been the norm, in the Middle East, to exempt students with RD from learning a second language, and to focus on developing literacy skills in their native language (Abu-

Rabia et al., 2013; Mohamadzadeh et al., 2020). Also, when a child is diagnosed with RD in Kuwait, parents are often afraid that exposing their RD child to two languages would be confusing and have negative effects. Therefore, the only research question in Study 2 was *"How do the linguistic and reading skills in children with RD who are attending a bilingual school compare with those attending a monolingual school (is there an advantage for bilingualism in children with RD?)"*. Past language exposure measures showed that the group attending monolingual schools were exposed to Arabic to a higher extent than the children attending bilingual schools, as expected. Therefore, Arabic receptive vocabulary scores were much higher for the group attending monolingual schools than for the group attending bilingual schools. This is in line with a previous study comparing dyslexic bilingual 10-year-old children (Italian as L2, different L1s) to monolingual Italian-speaking dyslexic children in which the dyslexic bilinguals showed lower receptive vocabulary in Italian than the dyslexic monolinguals (Vender & Melloni, 2021). However, these lower receptive vocabulary scores in Arabic in the bilingual children with RD in the current study were not correlated with their reading scores (see Appendix 12), nor their phonological and morphological scores, as was also seen in Vender and Melloni's (2021) study. Higher receptive vocabulary scores for monolinguals between the age of 3 and 10 were also seen in a study comparing TD bilinguals (English as L2, non-English L1) to TD English-speaking monolinguals (Bialystok et al., 2010). However, these lower receptive vocabulary scores did not affect bilingual children's academic achievement (Bialystok et al., 2005). Since the lower vocabulary scores are not a disadvantage, then the authors argue that this is just a detail to take note of in research designs involving bilingual and monolingual participants. In fact, when the receptive vocabulary scores were analysed into further categories in Bialystok et al.'s (2010) study, the proportion of vocabulary words that were lower in bilinguals compared to monolinguals were words related to the home. The authors argued that because these bilinguals were not speaking English in their homes, they were using their home language for these words. Therefore, if you combine words in their home language to words related to their English schooling, then the bilinguals' total vocabulary would be larger than the monolinguals. The children with RD in the current study were tested on receptive vocabulary in Standard Arabic, the language of their schooling, which contains different vocabulary words than Spoken Arabic used in the home (Saiegh-Haddad & Spolsky, 2014). Since the parents of the bilingual children with RD also reported using English in the home, then the same logic can be applied in which the total vocabulary of the bilingual children with RD in this study, which included standard Arabic, spoken Arabic, and English, may be larger than the monolinguals.

Results also showed that the children with RD attending bilingual schools and the children with RD attending monolingual schools had equivalent linguistic scores (phonological processing and MA). This is in line with a previous study, mentioned above, comparing dyslexic bilingual 10-year old children (Italian as L2, different L1s) to monolingual Italian-speaking dyslexic children where both groups of children had equivalent phonological awareness scores (Vender & Melloni, 2021), equivalent phonological memory scores (Vender et al., 2020), as well as higher scores on an inflectional morphology task in dyslexic bilinguals than dyslexic monolinguals (Vender et al., 2018). These results lend support to the notion that being exposed to two languages does not hinder RD children's phonological and morphological skills, which are considered core skills required for reading in both English (Snowling, 1980, 2013; Stanovich & Siegel, 1994; Vellutino et al., 2004; Vellutino & Scanlon, 1987; Wagner & Torgesen, 1987) and Arabic (Abu-Rabia et al., 2003; Elbeheri & Everatt, 2007; Layes et al., 2015; Mannai & Everatt, 2005; Saiegh-Haddad & Taha, 2017; Smythe et al., 2008). However, on the contrary, children with RD are showing equivalent linguistic skills in both languages and being exposed to two languages provides a cultural advantage of learning to read, write, and speak in an additional language. Having said that, it is important to bear in mind that the current study sample had a small sample, and the children were recruited from one monolingual school due to issues related to COVID influencing recruitment, discussed in a later section. It is hard to say if it was this school or the fact that it was monolingual that influenced the results of the current study. A larger sample of children with RD attending several monolingual and bilingual schools should be examined in future studies to confirm the current study's results.

Results examining the reading scores of the children with RD showed no differences in reading fluency scores between the bilingual and monolingual groups, but scores on reading accuracy were significantly higher for the group attending monolingual schools than bilingual schools and the difference had a small effect size. This contrasts with results from a previous study examining third to sixth grade students with specific learning disabilities and specific language impairment who were attending an immersion program in the US in which the bilingual students attending the immersion program achieved higher scores in reading on English state assessments than monolinguals that were not attending the immersion program (Thomas et al., 2010). The sample size in that study was small, and the language of comparison was different. There are no studies that have examined Arabic-English children with RD attending bilingual schools and Arabic-speaking children with RD attending monolingual schools to compare the results with. However, there have been intervention studies that have examined the effect of carrying out an intervention in English (L2) on bilingual Arabic-English 12-14 year old poor readers in Israel (Abu-Rabia & Salfety, 2021; Abu-Rabia et al., 2013). The intervention focused on reinforcing and mastering linguistic skills (orthographic, phonological, morphological, syntactic) as well as focusing on skills related to reading and reading comprehension. The studies have found that both Arabic (L1) and English reading and linguistic skills improved because of the intervention that was carried out in English. This evidence shows cognitive retroactive transfer (CRT), which is when a student uses cognitive skills that were learned later (L2) to skills that were learned at an earlier time (L1) (Abu-Rabia & Salfety, 2021; Abu-Rabia et al., 2013), see Section 2.6.6. Abu-Rabia et al. (2013) argue that children with RD should not be exempt from learning an additional language, and with carefully planned learning goals and effective teaching methods employed in L2, improvements in L1 would also be seen. In Abu-Rabia and Salfety's (2021) study, the dyslexic students were divided into three groups: mild, moderate, severe dyslexia, and the improvement in L1 skills in the mild group was significantly higher than the improvement seen in the moderate and severe group. This suggests that dyslexic students are heterogenous and not all students respond to learning an additional language in the same way. Therefore, the carefully planned learning goals in L2 should be individualized based on each case. The next section addresses the limitations of the current study.

5.11. Limitations

5.11.1 Sample, recruitment, and matching groups

The current study has several limitations. Since previous research has focused on monolingual children and the need for more research related to bilingual children with and without RD had been identified, then this limits the study sample to children attending private schools in Kuwait because only private schools offer bilingual education (see Section 1.2.). Future studies should include children from public and private schools for the sample to be more representative of the population as opposed to just half that population, as is the case in the current study. The current study also focuses on a specific age group only (age 9 to 11), and the inclusion of younger and older children to future studies would examine how linguistic skills develop and whether their contribution to reading changes as children develop.

Due to time constraints and COVID impacting the recruitment of participants, the sample groups were relatively small in size, which could increase the risk of a type I and type

II error (Field, 2018). Also, had the sample been larger, then parametric analyses such as regression could have been used to analyse the contribution of different variables to reading. Most of the sample came from the Kuwaiti population only with a minority representing other Arab countries. This means that results cannot be generalized to all Arabic-English bilingual students as other Arab nations have different educational systems and different dialects, which may impact students' performance on linguistic skills (Tibi, 2016). One Arabic dialect might pronounce the same letter differently than another Arabic dialect influencing the linguistic distance to standard Arabic. Future studies should include bilingual students from several Arab countries so that results can be generalisable to all Arabic-English bilingual students. Although the current study excluded students if the nature of their learning difficulty was not related to word-reading (decoding and fluency in particular), the study still included students with different RD subtypes. Future studies should include a wider range of RD (including reading comprehension difficulties as well), but then separate RD subtypes into different groups to examine differences, if any, in linguistic skills and their relationship to reading outcomes.

The research design included an age-matched control group for Study 1 when comparing TD and RD children attending bilingual schools. However, it lacks a control group that is matched on reading level. It is important to include both a reading-level matched control group as well as an age-matched control group when researching different patterns of reading development (Goswami & Bryant, 1989). This would help to understand further the different patterns of reading development in each language. However, the purpose of the study is to examine associations among linguistic and reading measures, and not the different pattens of RD. Also, it would have been interesting to compare the TD bilingual group to a group of TD monolingual English students and a group of TD monolingual Arabic students to compare the associations between MA and reading within each of the groups. This would have enabled the current study to examine whether bilinguals show a similar or different pattern to monolinguals in terms of reading strategies rather than compare them to previous monolingual studies from the literature. However, due to COVID, which will be discussed below, it was very hard to access the public schools to recruit a monolingual Arabic sample. This could be an area to explore for future studies.

5.11.2 Tasks

Since the morphological tasks were presented using a combination of oral and written modalities certain factors in each modality may influence the performance of children with

RD (Deacon et al., 2008). The limitations of the oral modality are that it stresses the articulation of the child and that children with RD may have weaknesses in their verbal short-term memory (Deacon et al., 2008). However, the positive aspect about the oral modality is that is ensures that there is less stress on the reader to read the question given his/her RD and so there is less risk that any weaknesses shown in the morphological task are due to their weak reading ability. The written modality in the current study always required the examiner to read the questions for the student to avoid any risk that any difficulties with the task are due to problems reading the question. Having said that, since the orthography preserves morphology in a consistent manner, then the written modality provides an advantage (Deacon et al., 2008). This advantage would give the poor reader more clues to tackle the task despite their phonological weaknesses. The written modality also requires orthographic knowledge which children with RD may also have weaknesses in. Therefore, a combination of both oral and written tasks was used, and phonological memory was controlled for in the analyses. It was especially important to control for phonological memory as the correlations between all the variables in the bilingual sample (Tables 11 and 12) showed that phonological memory was highly correlated with MA in both languages. Another limitation is related to the reliability of the judgement tasks in both English and Arabic. Reliability should have been calculated during the pilot study before administering the tasks to the participants of the current study. That way any tasks with low reliability would have been modified. A solution was done by combining the oral and written modality of the judgement task resulting in a reliability of 0.7. This level of reliability is acceptable, but it can be enhanced by adding more items on the task. Tasks with low reliability restrict the ability of finding relationships between variables statistically (Deacon et al., 2007). Therefore, this might have influenced the lower contributions of MA to reading in the current study sample. As mentioned in section 2.4.4., Tibi and Kirby's (2017) study examining several Arabic MA tasks highlighted that the oral and written tasks loaded on separate factors in their factor analysis. Therefore, this is an additional limitation to the current study where oral and written tasks were initially separate tasks but were combined to solve the reliability issue. Based on Tibi and Kirby's (2017) findings, future studies should use separate oral and written tasks. Although the Arabic judgement task essentially assesses whether the two words come from the same root, it is not considered a valid measure of root awareness (Tibi et al., 2019). The use of a psychometrically valid measure of root awareness such as the one developed in Tibi et al.'s (2019) study would have strengthened the findings given the importance of root awareness in Arabic reading and its predictive validity. However, this task is only available in the written modality and an oral version should be used in future studies especially those that include children with RD (Deacon et al., 2008). The task would need to be adapted for the oral version as the written version presents a target word and six choices of words and asks the child to choose words that belong to the same family. Presenting six choices of words orally would stress verbal short-term memory especially for children with RD. Finally, the current study employed a stop rule if the student made four consecutive errors on several tasks that were not standardized. This was a mistake as there was a limited number of items on the tasks, and the items were not sorted based on increasing difficulty, and thus when the stop rule was applied, this led to an unnecessary reduction in the number of items available for analysis.

Another limitation is that the reading accuracy task in English mostly contained word stems that were not morphologically complex (e.g. had only one morpheme such as 'come' or 'made'). Reading tasks should be carefully selected, as mentioned in Sections 2.2.2. and 2.4.5., because how morphologically transparent the word is (Saiegh-Haddad & Geva, 2008), how frequent the base (Deacon et al., 2011), how large the morphological family is (Rueckl, 2010), all contribute to the extent that MA is related to word reading. Factors at the word-level such as number of morphemes have also been shown to significantly influence Arabic word reading (Tibi et al., 2020), and including reading tasks with greater numbers of morphemes may also contribute to the extent that MA is related to word reading.

Another limitation to the current study was that the tasks used in the current study to measure MA measure only one dimension of MA. Researchers have identified three different dimensions of MA related to English word identification: morphological structure awareness, morphological decoding, and morphological analysis (Carlisle, 2000; Kuo & Anderson, 2006), see section 2.4.5. Future studies should include these additional dimensions of MA and explore their relationship further among children attending bilingual schools.

Additional limitations to the study include the lack of norm-referenced tests that measure MA that have been designed to be administered on a specific population. Meanwhile, in the case that this study used norm-referenced tests, a limitation still existed as these norm-referenced tests contain psychometrics properties that have not been designed to cater to the bilingual population in Kuwait as they were normed on monolinguals either in Kuwait (for the Arabic tests) or abroad (for the English tests). Additionally, some of the test items were designed with monolinguals in mind; therefore, a receptive vocabulary test like the BPVS may overestimate weaknesses in vocabulary when administered on a sample in which English is the second language. Also, the current study used the Elision subtest only to measure phonological awareness and the rapid letter naming subtest only to measure RAN. The original battery of standardized tests uses additional tasks to measure a construct such as PA or RAN. These additional tasks should be used in future studies to be able to measure each construct with all its dimensions.

5.11.3 Additional controls

Previous studies have shown that orthographic processing influences reading in English (Berninger et al., 2010; Deacon et al., 2009; Ehri, 2017) and Arabic (Abu-Ahmed et al., 2014; Asadi & Shany, 2018; Tibi & Kirby, 2019). Tibi and Kirby's (2019) study examined 8-year-old Arabic-speaking students in the UAE. Results showed that orthographic processing was related to reading outcomes among particularly the poor decoders but not the good decoders. However, the current study did not measure or control for the effects of orthographic processing on reading within each language, and future studies should control for this. This is especially important as the morphological tasks were presented using a combination of both oral and written modalities, and orthographic processing may have influenced the performance on the written morphological tasks (Deacon et al., 2008). The MPF (Levesque et al., 2021) argues that children's processing of morphemes in English as well as Arabic (Tibi & Kirby, 2019) is separate than their processing of orthographic units. The current study was not able to provide evidence to support this claim because it did not measure or control for orthographic processing within each language, which future studies should examine. Another measure that was not controlled for is expressive vocabulary. Future studies should include this measure to control for language delays (Catts et al., 2017).

Studies in Arabic (Tibi et al., 2019) and English (Berninger et al., 2010; Kirby et al., 2012; Nagy et al., 2006) have shown evidence that MA is associated with reading when vocabulary is controlled for. However, since morphemes represent meaning, then MA and vocabulary have been shown to be associated with each other (Goodwin et al., 2013). The current study does not control for vocabulary in research question 3C when the TD and RD groups were examined separately. The rationale for that was due to the small sample size and reduced power of the analyses. Future studies with higher sample size should control for receptive vocabulary when examining associations between MA and reading within the two groups. However, the use of non-word stimuli and real word stimuli in the MA tasks in the current study helps to separate the contribution of vocabulary and MA to reading (James et al., 2020).

5.12. Challenges faced during COVID

All schools suddenly closed due to the pandemic several months before data collection. The current study was able to obtain ministry approval to recruit participants from three bilingual private schools and three monolingual private schools. The ministry did not give approval for any public schools to participate in research studies during the pandemic. After obtaining approval from the ministry and contacting the administrations of the schools, two schools out of the three bilingual schools agreed to participate. It was difficult to recruit schools to participate in the study as the staff and administration were facing unprecedented circumstances. The third school refused to participate claiming that the parents and students are under too much pressure at the time. Two schools out of three of the monolingual schools agreed to participate. Online links were sent by the schools to parents including information about the research study and consent forms. It was very difficult for parents to be interested in taking the time to participate in a voluntary research study at a time where all children were home participating in online schooling. It was also difficult for the parents to not be able to see the researcher in person and ask them any questions. Therefore, parents were offered to contact the researcher by telephone to answer any questions or concerns. There were lockdowns and curfews imposed by the government at that time, so the children were mostly spending time at home after their online schooling hours were over. Parents were either working outside of the home or were working from home, and access to childcare was limited. Therefore, they found it very difficult to find the time to participate in the research study regardless of their SES. This is the main reason behind the small sample size in the current study. Another concern the parents expressed was the lengthened exposure to screen time. They were concerned that after spending all day participating in online school, it would be gruesome to expose them to an additional hour of screen time to participate in the study. Students were recruited in the two bilingual schools and one monolingual school. No parents were willing to participate in the second monolingual school. After the students were recruited, several challenges were faced when administering the tasks online. Students would get bored and tired, and it would be difficult to engage their attention from behind the screen, so several breaks were given. It was also difficult to ensure that the child was not getting any help with the tasks as the students were only participating through audio and not through video. Internet issues and sound issues were also a problem especially during the timed tasks.

This affected the administration of the tasks and therefore should be taken into consideration along with the limitations of this study that were discussed above. The next chapter will conclude the thesis by summarizing the research findings, discussing the implications of the research, evaluating the research, and make suggestion for future research.

6. Conclusion

6.1. Summary of research

One of the aims of this thesis was to examine the role of MA in word reading in Arabic-English students attending bilingual schools in Kuwait to further explore whether theories that were based on findings from monolingual Arabic-speaking and English-speaking students can apply to biliterate children. Previous reading models (Coltheart et al., 2001; Ehri, 2005b; Hoover & Gough, 1990) have focused largely on the role PA plays in English reading, which was found to be important, but recent literature has identified the importance of MA as well (Levesque et al., 2021), a skill that has been largely ignored in theories of reading development (Rastle, 2019). In fact, the results of the current study showed that the role MA played in English word reading was consistent with published monolingual literature (Nagy et al., 2006) and played a significant role in reading exception words in 9–11-year-old biliterate children in Kuwait. Since biliterate children have been under-researched, there is a need for further research as globalization has increased the amount of biliterate children in the world (Lin & Man, 2009). In fact, the results of the current study have shown that MA plays a role in Arabic word reading in biliterate children, but this role is smaller than the role it has been reported to play in published literature relating to Arabic monolingual children (Saiegh-Haddad & Taha, 2017), especially in unvoweled word reading. The possible reasons for this discrepancy in findings are discussed in the previous chapter.

Another aim of this thesis was to examine the role MA plays in word reading among biliterate Arabic-English children with RD attending bilingual schools. Children with RD who are biliterate have rarely been examined in previous published literature, though it has been argued that children with RD may use MA skills to compensate for their weaknesses in PA skills while reading (Casalis et al., 2004; Cavalli et al., 2017; Elbro & Arnbak, 1996). The current study goes further than previous studies in examining PA and MA skills in children with RD by using single-case methods in addition to group analyses. The results showed that although the group analyses showed no use of MA in English word reading among the children with RD, the single-case analyses showed that six of the total 19 cases showed a dissociation (stronger morphological than phonological skills) between PA and MA skills on both the morphological tasks administered. The magnitude of dissociations was correlated with their reading skills indicating that children with RD may use MA skills to compensate for weaknesses in PA skills when reading. As for Arabic, the group analyses showed that children with RD may use MA skills in nonword reading fluency and voweled reading tasks, which in turn may indicate that they may be using their MA skills to compensate for weaknesses in their PA skills as these tasks require a high amount of phonological recoding. The single-case analysis, however, did not show a dissociation between PA and MA skills in Arabic as the children with RD did not show significantly stronger morphological skills than phonological skills.

Finally, the last aim of this thesis was to compare children with RD attending bilingual schools and monolingual schools. This was to address the real-life problem parents face when deciding whether their child with RD should attend a bilingual school or not. The results showed that there were mostly no differences between Arabic linguistic and reading skills of the children with RD attending bilingual schools compared with the children with RD attending a monolingual school. There was a small difference in terms of their reading accuracy skills and a large difference in terms of their receptive vocabulary due to lower exposure to Arabic compared to the monolinguals. The next sections address the implications of the current research, the recommendations moving forward, suggestions for future work, and an evaluation of the current research.

6.2. Implications and recommendations

Identifying the precise roles MA plays in both English and Arabic word reading, which the current study attempted to do, has the potential to help educators understand how to include it as part of instruction. Kirby and Bowers (2017) argue that morphological instruction is a relatively new field compared to the instruction that has focused on phonology and vocabulary, which have been refined over many years of research. Further research focusing on important content areas to teach may improve the effectiveness of the morphological interventions. As argued by Levesque et al. (2021), it's not enough to say that morphology should be included as part of regular instruction. The exact aspect of morphology that should be taught must be identified, how it can be taught in an effective manner resulting in the largest impact on reading, to which age group, and whether children as a whole benefit from morphological instruction or just children with RD are all areas future research should examine and identify (Breadmore et al., 2021). Examining and identifying these key points related to morphological instruction would help policy makers know what to include as part of school instruction (Breadmore et al., 2021). Previous research has shown that younger monolingual children (in preschool and early elementary) benefited more from English morphological instruction than older children (Bowers et al., 2010; Goodwin & Ahn, 2013). Research examining Arabic-speaking students has agreed on the importance of MA in Arabic reading (especially root awareness) in early grades and that explicitly teaching children to be aware of morphemes in words (especially words with a high number of morphemes) and how to manipulate them should be included in instruction along with phonics instruction (Makhoul, 2017; Saiegh-Haddad & Schiff, 2016; Tibi et al., 2020; Tibi et al., 2019). However, authorities in charge of education in the region have not implemented these findings, and have designed teaching strategies and content to emphasize phonics only, which is not enough (United States Agency for International Development, 2019). It is important to align government initiatives and policies with the findings of educational research.

The current study also showed the importance of MA skills in children with RD. Previous research has also shown that English morphological intervention studies were more effective on "less able" children, which included monolingual children with dyslexia and poor readers and spellers (Bowers et al., 2010, p. 147). The reason that these weaker readers benefited more is not clear but could be attributed to their poor phonological skills and the use of morphology as a compensatory strategy (McCutchen et al., 2014). However, it has always been recommended that children with RD receive phonological instruction as it has been proven to be effective (National Reading Panel, 2000). Some researchers have even recommended avoiding morphological instruction in the first few years of reading instruction (Adams, 1990). Kirby and Bowers (2017) recommend integrating both phonological and morphological instruction especially for children with phonological deficits because morphology may support their reading. As mentioned earlier, children with RD are heterogeneous so individualized plans based on strengths and weaknesses should be examined before deciding what type of intervention is needed, whether it is one that is focused on PA, MA, or both, and whether it is administered in an L1 or L2. As the current study showed, there was no harm for children with RD to be biliterate, learn an additional language, and benefit from all the cultural advantages that this provides. However, this could depend on the severity of the reading difficulty and should be evaluated on a case-by-case basis (Abu-Rabia & Salfety, 2021). It is recommended to increase the percentage of teachers with proper qualifications that enable them to evaluate, and construct individualized educational plans for children with RD and provide them with the support that they need.

The results of the current study showed the reduced use of Arabic morphological skills while reading among biliterate students compared to monolingual samples of similar age groups seen in previous published literature (Saiegh-Haddad & Taha, 2017; Tibi & Kirby, 2019). This was explained as perhaps being related to reduced exposure to Arabic in the home (Zhang & Ke, 2020), and reduced exposure to Arabic reading in school (Deacon et al., 2007), which might have influenced lexical quality (Perfetti, 2007) and decoding strategies (McBride & Mohseni, 2023). As mentioned in Section 1.2., Arabic learning poverty is a phenomenon that students suffer from in the current region (World Bank, 2019). Therefore, it is recommended that national campaigns to raise awareness about the importance of speaking Arabic in the home and the importance of reading Arabic books to children in the home would help increase exposure to Arabic. Variance explained by MA in unvoweled reading was lower in the current study sample compared to monolingual samples in previous published literature (Saiegh-Haddad & Taha, 2017). As mentioned in Section 2.6.3., it is recommended that before making the switch to unvoweled reading at a certain grade cut-off, both TD students and children with RD are evaluated to ensure that they have enough knowledge of morphology, vocabulary, and syntax to make the transition to unvoweled reading easier (Saiegh-Haddad, 2018).

Since diglossia creates a linguistic distance between spoken Arabic and standard Arabic and has been shown to influence reading (Saiegh-Haddad, 2003, 2004, 2005), it is recommended to increase children's exposure to written standard Arabic in their kindergarten years as a previous intervention study has shown that this exposure helps children with reading when they get to the first grade (Asadi et al., 2023). The ministries in the region provide students with textbooks to read, but what is lacking in the region is the availability of Arabic story books and reading material that is fun for children, which should be provided to help develop their reading skills (United States Agency for International Development, 2019).

As mentioned in Section 2.3.5., certain features of Arabic letters make them more complex than English letters (Verhoeven & Perfetti, 2022), and evidence has shown the importance of orthographic processing in Arabic word reading (Tibi & Kirby, 2019). The findings of the current study also showed that the TD group had high variability in the Arabic RAN scores and did not all perform well on speeded letter naming in Arabic. Arabic instruction should focus on learning Arabic letters well especially their different shapes according to their position in the word (Tibi & Kirby, 2019). In addition, the findings of the current study also showed that the children with RD showed weaknesses in speeded letter naming in Arabic and English. Previous studies have shown that it is difficult to improve naming speed alone (Kirby et al., 2010), and it is recommended that interventions targeted at children with RD focus on improving orthographic processing and reading fluency (Tibi & Kirby, 2019).

The children with RD in the current study showed weaknesses in phonological processing and morphological awareness. Children are usually screened using phonological awareness tasks to help identify children at risk of having a reading difficulty (Torgesen et al., 1997). Other naming speed tasks such as object naming tasks may be used to screen children before they start to learn how to read (Tibi & Kirby, 2019). The use of morphological awareness tasks (especially root awareness) may be used as well to screen children given its importance in Arabic reading (Tibi et al., 2019). These tasks should also be included in the battery of assessments used to identify whether a child has a reading difficulty.

As mentioned in Section 1.2., one of the factors contributing to Arabic learning poverty is the lack of time dedicated to teaching Arabic language in schools in the region (International Association for the Evaluation of Educational Achievement, 2016), and it is recommended that schools increase the percentage of this dedicated time and allow additional time for students to practice reading in the classroom (United States Agency for International Development, 2019). It is also recommended to change the way that Arabic language has been taught and incorporate an updated curriculum focused on explicitly teaching knowledge of phonics, morphology, orthography, and syntax (United States Agency for International Development, 2019). That should also be done alongside updating teacher-preparation programmes with this content, teaching them to use updated evidence-based pedagogy skills, giving them time to practice this knowledge in the field, and providing them with continuous professional development while on the job (United States Agency for International Development, 2019).

The results of the current study have theoretical implications that may raise questions about the extent to which general reading theories can account for reading in non-English/European orthographies. The importance of PA in voweled Arabic reading, despite it having consistent GPCs, shows how Anglocentric the orthographic depth hypothesis (Katz &

Frost, 1992) is. That is in the sense that it only focuses on consistency of GPCs, due to it being an important factor in English and European orthographies, and it does not consider several other factors (e.g. missing vowels, visual similarity of letters, ligaturing, different forms of letters depending on position in word, letters that represent both consonants and vowels, and diglossia discussed in Sections 2.3.2. and 2.3.6.) that add to the definition of orthographic depth in relation to the Arabic orthography (Daniels & Share, 2018). In addition, the different patterns of associations between MA and Arabic voweled vs unvoweled word reading accuracy among the biliterate children in the current study compared to monolinguals in previous studies in the literature also highlights the fact that theories that were based on monolingual readers (Saiegh-Haddad, 2018) may not apply to bilingual readers who may show different strategies of reading due to differences in their language exposure (McBride & Mohseni, 2023). Finally, the results of the single-case analysis also highlight that word reading theories that were based on group analyses especially those that include children with RD may not capture the individual differences seen in such a heterogenous group of children. Therefore, future research should consider orthographies of different types, monolingual and bilingual learners, and employ several different analyses when examining children with RD to understand reading from a more universal lens. The next section provides additional suggestions for future research.

6.3. Suggestions for future research

As mentioned in Section 2.2.1, reading requires decoding and linguistic comprehension (Gough & Tunmer, 1986). The current study focuses on the decoding aspect of reading only and does not examine other aspects of literacy such as reading comprehension or spelling. Future research should explore how MA influences spelling or reading comprehension in students with or without RD attending bilingual schools. In addition, the study focused on the derivational aspect of morphology only and did not include awareness of inflectional morphology. Further research should compare inflectional and derivational morphology skills, and the role they each play in relation to reading and RD in both monolinguals (Saiegh-Haddad, 2017) and bilinguals.

The current study examined within language associations only and did not examine cross-linguistic associations. That is because to examine cross-linguistic associations, it is necessary to establish task equivalence across the tests used in the two languages, which presents a key methodological challenge in research of this type (Koda, 1994). When two constructs are compared across two languages, the instruments used should be equivalent.

The instruments can be equivalent by controlling several factors such as how long words are in each language, structure of syllables, familiarity and frequency of words, and morphological structure (Geva & Siegel, 2000). However, it is difficult to achieve task equivalence by controlling all these factors because sometimes if words are directly translated from L1 to L2, the word in L2 may not be equally familiar or may have a different syllable structure or morphological structure. Therefore, researchers have to compromise on which factors to control across instruments in different languages because if all components are controlled, then this would result in a limited amount of words and it would be difficult for researchers to examine reading development regardless of the orthography (Geva & Siegel, 2000). A solution would be to use standardizes tests, but as mentioned in section 5.11., standardized tests are usually normed on monolingual populations so their use on biliterate students also creates limitations. Future research should explore cross-linguistic associations while bearing in mind limitations to task equivalence.

The current study is correlational in nature and examines MA that has accumulated in students over the years as a result of exposure to oral language and reading (Kirby & Bowers, 2017). Additional studies should examine whether explicitly teaching MA in an intervention study to biliterate students with or without an RD in English or Arabic influences reading outcomes to shed light on whether MA is causally related to reading. In addition, studies employing in-class observation methods to study how reading is being taught in bilingual and public schools in Kuwait should be explored so that improvements to teaching, if any, may be recommended.

Finally, as mentioned in section 1.2, parents rarely read to their children in Kuwait (International Association for the Evaluation of Educational Achievement, 2016) and that influences literacy (Korat et al., 2014). Future studies should examine the home literacy environment in Kuwait and its relation to reading among biliterate children and children with RD.

6.4. Evaluation of the current research

A key limitation of the current research was not measuring the reliability of the MA tasks during the pilot study and improving their reliability before administering them in the current study. Another limitation would be the small sample size. Both factors limit the degree to which findings might generalise to the broader population, and further research will be necessary to confirm findings. The current study did not include an assessment of the role of orthographic processing, which may be informative especially in a complex orthography like Arabic where the unique morphemic structure is orthographically transparent (Mahfoudhi et al., 2010). The use of non-parametric tests in the current study restricted the investigation of the individual contribution of the predictor variables to reading and the use of multiple regression analysis would have extended understanding of the relative roles of PA, MA, and vocabulary to reading.

The most valuable aspect of this research was that it tackled a real-world problem that parents face when deciding what type of schooling their child with RD should attend. This would allow parents to make decisions that are based on research evidence. It was also important to examine students that were reading in Arabic because theories developed based on English and European orthographies, which make up a large portion of the published literature, may not apply to the Arabic orthography, which uses the unique Abjad alphabet that employs a unique morphemic structure (Share, 2008a). The inclusion of other orthographies that have been under-researched helps to build a more universal picture of reading as opposed to just focusing on English and similar orthographies (Verhoeven & Perfetti, 2022). This study also provided a valuable bridge between using different methods to examine children with RD (group analyses and single-case analyses) to help understand a heterogenous group of children and to highlight the importance of MA in reading among children with RD in both English and Arabic.

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Appendices

Appendix 1

Ethics form

University of Reading
Institute of Education
Ethical Approval Form A (version May 2019)

Tick one:

Staff project: _____ PhD __√__ EdD ____

Name of applicant (s): Lujain AlMatrouk

Title of project: The relationship between morphological awareness and reading accuracy and fluency among bilingual Arabic-English mainstream and learning disabled (LD) children in Kuwait

Name of supervisor (for student projects): Dr Holly Joseph & 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) Staff Only - have you taken the online training modules in data protection and information security (which can be found here: http://www.reading.ac.uk/internal/humanresources/PeopleDevelopment/newstaff/humres-MandatoryOnlineCourses.aspx Please note: students complete a Data Protection Declaration form and submit it with this application to the ethics committee.	✓		
5) Have you read the Health and Safety booklet (available on Blackboard) and completed a Risk Assessment Form (included below 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[2], 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			

- Complete **either** Section A **or** Section B below with details of your research project.
- Complete a risk assessment.
- Sign the form in Section C.
- Append at the end of this form all relevant documents: information sheets, consent forms, tests, questionnaires, interview schedules, evidence that you have completed information security training (e.g. screen shot/copy of certificate).
- Email the completed form 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.	

[2] 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.

90 students will participate in this study between the ages 9 and 12, 30 of which will be typically developing children attending a bilingual school in Kuwait (control group). An additional 30 will be students who have a learning disability diagnosis (LD) from a diagnostic centre in Kuwait and attend a bilingual school (Experimental Group 1). An additional 30 students will be LD students attending a monolingual school (Experimental Group 2).

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 them.
7. estimated start date and duration of project

Title of the project

The relationship between morphological awareness and reading accuracy and fluency among bilingual Arabic-English mainstream and learning disabled (LD) children in Kuwait

Purpose of project and its academic rationale

The purpose of the study is to examine the relationship between the awareness of meaning components of words (morphological awareness) and reading in both English and Arabic among bilingual students and students with LD attending a bilingual school and monolingual school (Arabic only). We know a lot about the relationship between morphological awareness to reading in monolingual Arabic and English students with and without LD but very little in bilingual (Arabic-English) students with and without LD.

Brief description of methods and measurements

Each child will be asked to do a series of tasks. One session will be dedicated to English tasks and another session with be dedicated to equivalent Arabic tasks. All tests (except the non-verbal ability test) and tasks will be administered in both English and Arabic (except for the monolingual children where only Arabic tests will be administered). Tasks will include (see attachment scoresheets of tasks):

- a standardized measure of nonverbal ability (Abdulraoof, 2009)
  requires selecting a pattern from a set of choices to complete a sequence (10 min)
- a standardized measure of receptive vocabulary or equivalent (Abu-Allam & Hadi, 1998; Dunn & Dunn, 1981)
  requires selecting one of four pictures that best describes a word's meaning (10 min)
- standardized measures of phonological memory, rapid naming and phonological awareness (Taibah et al., 2011; Wagner et al., 1999)
  includes repeating sounds from memory, deleting sounds from words and matching sounds with letters (7 min)
- tasks to measure morphological awareness adapted from or equivalent (Carroll & Breadmore, 2018; James et al., 2020; Kirby et al., 2012; Mahfoudhi et al., 2012; Mahony et al., 2000; Nagy et al., 2006; Nunes et al., 1997; Saiegh-Haddad & Taha, 2017; Tibi, 2016)
  includes identifying whether words share the same root and producing real words or non-words using a real-word analogy (10 min)
- a standardized measure of reading accuracy (Forum for Research in Literacy and Language, 2012) and reading accuracy tasks from (Saiegh-Haddad & Taha, 2017)
  involves reading aloud lists of words and non-words accurately (10 min)
- a standardized measure of reading fluency (Torgesen et al., 1999) and a task adapted from (Tibi, 2016)
  involves rapidly reading aloud a list of words (2 min)

Parents will be asked to fill out a questionnaire about their child's past language exposure in an online version adapted from The Utrecht bilingual language exposure questionnaire (Unsworth, 2013) and additional questions about their educational level (see the questionnaire in the following link: https://forms.gle/SZGxHMVy7JqE25QW7) Redcap software will be used to distribute and manage data of online questionnaire. The parents will have an option to choose to fill out an English or Arabic version of the questionnaire. Due to restrictions related to COVID-19, the above tests and tasks will be delivered virtually, using university-approved video conferencing software, because access to children in schools is not permitted.

Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria

90 Children will be recruited between the ages 9 and 12. Two bilingual schools will be approached that provide inclusion classes for mainstream children and students diagnosed with LD in Kuwait. Children will also be recruited from a special school for students with LD where most of the language instruction takes place in Arabic.

Consent and participant information arrangements, debriefing (attach forms where necessary)

Informed consent will be sought from principals and parents (see attached information sheets and consent forms) and children will also be informed of the study and asked to verbally assent (see attached student information sheet). Different versions of information sheets were prepared for parents, principals, and children according to their group in the experiment. All information sheets and consent forms will be distributed in both English and Arabic (directly translated from the English versions attached). Redcap software will be used to distribute online information sheets and consent forms to parents to receive e-consent in the form of an e-consent framework provided by Redcap in which the e-consent is converted to pdf and archived (English only). However, the Arabic versions of e-consent will be provided by adding their name, signature, date, and ticking checkboxes to express their consent (as the conversion to pdf does not work for Arabic).

A clear and concise statement of the ethical considerations raised by the project and how you intend to deal with them.

As outlined in the information sheets, data collected will be anonymised and the identity of participants and schools will be treated confidentially. Children will be offered breaks between tasks and reassured that they can withdraw without any consequences and that only research team will know about their answers.

Estimated start date and duration of project
Estimated start date is for November 2020 until February/March 2021.

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

RISK ASSESSMENT: Please complete the form below

Brief outline of Work/activity:	This study is experimental in nature and will last for 4-5 months. Participation in this study involves having the students complete tasks related to reading skills and reading. A questionnaire will be administered to parents of children to measure the past language exposure of their child. The study will start in February 2021 and will last until June 2021.

Where will data be collected?	Testing will take place in schools in Kuwait, and questionnaire will be filled online, which is the most convenient for all participants. Due to COVID-19 restrictions, testing will take place virtually using university-approved video conferencing software.

Significant hazards:	None identified. The schools are safe environments

Who might be exposed to hazards?	None identified.

Existing control measures:	The schools follow the local authorities' health and safety regulations. In relation to COVID-19, if the testing takes place in schools, safety measures enforced by the school/government will be meticulously followed.

Are risks adequately controlled:	Yes

If NO, list additional controls and actions required:	Additional controls	Action by:

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: Lujain AlMatrouk Date: 8/02/2021

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: Holly Joseph Date 10 February 2021

(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.

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University of Reading

Researcher:

Mrs. Lujain AlMatrouk

Email: l.y.almatrouk@pgr.reading.ac.uk

Supervisors:

Dr Holly Joseph

Email: h.joseph@pgr.reading.ac.uk

Dr Daisy Powell

Parent/Carer Information Sheet
(Version 1 – to be given to parents of children in the control group)

Research project: The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Project team members: Lujain AlMatrouk (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)

This is an invitation for your child to participate in a research study about morphological awareness and its relationship to reading.

What is the study about?

The purpose of the study is to examine the relationship between morphological awareness and reading among bilingual students and students with LD. Morphological awareness is the awareness of the meaning components of a word. For example, being aware that if 'er' is added to the word 'play,' then the word 'player' is produced, and that 'er' usually indicates the person doing the action. This skill is important because research has shown that children use this skill when reading Arabic and English, and it is important to examine these skills in children with different reading profiles to make appropriate recommendations for their education.

Why has my child been chosen to participate in this study?

Your child has been chosen to participate in this study because he/she is between the ages 9 and 11 and is learning to read in a bilingual school in Arabic and English.

Does my child have to participate in this study?

No. It is you and your child's choice to participate in this study. If you would like your child to participate in this study, please fill out the attached consent form and return it to your child's teacher.

What will happen if my child participates in this study?

With your consent, during school hours, your child will be asked to complete several tasks individually. This will take place over two sessions. Each session will be approximately 60-80 minutes each. An additional session may be scheduled, if needed, in the case where the student was not able to complete all the tasks required. The child will be given the opportunity to take several short breaks when necessary. In the case where circumstances beyond our control cause the session to stop, then the session will be rescheduled to be completed on another day. All safety measures relating to COVID-19 enforced by the government/school will be followed meticulously. Due to restrictions related to COVID-19, the above tasks will be delivered virtually, using university-approved video conferencing software, because access to children in schools is not permitted.

One session will be dedicated to tasks in English and another session will be dedicated to equivalent tasks in Arabic. The equivalent tasks in English and Arabic will be related to reading skills where your child will be asked reflect on the sounds in words, rapidly read aloud a set of letters, produce new words from root words, and identify whether words share the same root. The session will also include reading tasks in which your child will be asked to read aloud a list of words and non-words (fake words that look and sound like real words) as accurately as they can. The sessions will be audio recorded to ensure the accuracy of the scoring. With your consent, we will ask the school to provide information about your child's date of birth to obtain his/her age.

You will also be contacted by the researcher through text message or email at the contact details you have provided in the consent form and you will be asked to fill out a short survey about your child's past language exposure to English and Arabic.

What are the risks and benefits of participating in the study?

The study poses no risk on the child or the parent for participating in the study. Your child may benefit from the additional practice related to reading through our tasks, which were carefully designed for children of this age and most children find them enjoyable. Your child can withdraw from the study at any time in the case he/she feels tired or upset.

What will happen to the data?

All records collected will be stored securely in a locked filing cabinet and on a password-protected computer. When the study is made available to the public, there will be no links to identify you, your child, or your school. All personally identifiable information collected for the project will be destroyed after 5 years. Any information from the study made available to fellow researchers will be anonymised. The data collected from you and your child in this study will be preserved and will be made available to other authenticated researchers in anonymised form, so that the data can be consulted on and reused by others. The results of the study may be presented at national and international conferences and published in written 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 upon request.

What happens if I/my child change our mind?

If you/your child decide to participate in this study and later change your mind, you can do so at any point in time without providing a reason and without any consequences by contacting me at the email address given above. 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 supervisors, Dr Holly Joseph (h.joseph@reading.ac.uk) and Dr Daisy Powell (d.a.powell@reading.ac.uk), at The University of Reading.

Where can I get more information?

If you would like more information, please contact Lujain AlMatrouk. Email: l.y.almatrouk@pgr.reading.ac.uk

I hope that you will agree to your child's participation in the study. If you want your child to participate, please complete the attached consent form sealed in the envelope provided and return it to your child's teacher.

Thank you for your time.

Kind regards,

Lujain AlMatrouk

Data protection for information sheets

The organisation responsible for protection of your personal information is the University of Reading (the Data Controller). Queries regarding data protection and your rights should be directed to the University Data Protection Officer at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

The University of Reading collects, analyses, uses, shares and retains personal data for the purposes of research in the public interest. Under data protection law we are required to inform you that this use of the personal data we may hold about you is on the lawful basis of being a public task in the public interest and where it is necessary for scientific or historical research purposes. If you withdraw from a research study, which processes your personal data, dependant on the stage of withdrawal, we may still rely on this lawful basis to continue using your data if your withdrawal would be of significant detriment to the research study aims. We will always have in place appropriate safeguards to protect your personal data.

If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact Lujain AlMatrouk – l.y.almatrouk@pgr.reading.ac.uk

You have certain rights under data protection law which are:

- Withdraw your consent, for example if you opted in to be added to a participant register
- Access your personal data or ask for a copy
- Rectify inaccuracies in personal data that we hold about you
- Be forgotten, that is your details to be removed from systems that we use to process your personal data
- Restrict uses of your data
- Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes. You can find out more about your rights on the website of the Information Commissioners Office (ICO) at https://ico.org.u. You also have a right to complain the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance.

University of Reading

Researcher:
Mrs. Lujain AlMatrouk
Email: l.y.almatrouk@pgr.reading.ac.uk

Supervisors:
Dr Holly Joseph
Email: h.joseph@pgr.reading.ac.uk
Dr Daisy Powell

Parent/Carer Consent Form

To be completed by a parent or guardian who **agrees** that their child participate in the study about: The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Researcher name: Lujain AlMatrouk

Please tick the box after each statement to confirm it has been read and agreed to. ✓

1. I have read and understand the accompanying Information Sheet relating to the above project.	
2. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.	
3. I have had explained to me what information will be collected about me, what it will be used for, who it may be shared with, how it will be kept safe, and my rights in relation to my data.	
4. I understand that participation is entirely voluntary and that I have the right to withdraw from the project any time, and that this will be without detriment.	
5. I give permission for the use of audio recordings of assessment sessions with my child.	

Parent/Carer Name: ………………………………………………………………………………

Child's Name: ………………………………………………………………………………

School name: ……………………………………………..

Parent/Carer Signature: ………………………………………………………………………………

Parent/Carer Phone Number or Email: ……………………………………………………

Date: ………………………………………………………………………………

I am happy to be included on a register of research participants for the purposes of being contacted about further studies by The University of Reading *(optional).* ☐

University of Reading

Researcher:

Mrs. Lujain AlMatrouk

Email: l.y.almatrouk@pgr.reading.ac.uk

Supervisors:

Dr Holly Joseph

Email: h.joseph@pgr.reading.ac.uk

Dr Daisy Powell

Parent/Carer Information Sheet
(Version 2- to be given to parents of children in Experimental Group 1)

Research project: The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Project team members: Lujain AlMatrouk (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)

This is an invitation for your child to participate in a research study about morphological awareness and its relationship to reading.

What is the study about?

The purpose of the study is to examine the relationship between morphological awareness and reading among bilingual students and students with LD. Morphological awareness is the awareness of the meaning components of a word. For example, being aware that if 'er' is added to the word 'play,' then the word 'player' is produced, and that 'er' usually indicates the person doing the action. This skill is important because research has shown that children use this skill when reading Arabic and English, and it is important to examine these skills in children with different reading profiles to make appropriate recommendations for their education.

Why has my child been chosen to participate in this study?

Your child has been chosen to participate in this study because he/she is between the ages 9 and 11 and has a learning disability (LD) diagnosis from the and is learning to read in a bilingual school in Arabic and English.

Does my child have to participate in this study?

No. It is you and your child's choice to participate in this study. If you would like your child to participate in this study, please fill out the attached consent form and return it to your child's teacher.

What will happen if my child participates in this study?

With your consent, during school hours, your child will be asked to complete several tasks individually. This will take place over two sessions. Each session will be approximately 60-80 minutes each. An additional session may be scheduled, if needed, in the case where the student was not able to complete all the tasks required. The child will be given the opportunity to take several short breaks when necessary. In the case where circumstances beyond our control cause the session to stop, then the session will be rescheduled to be completed on another day. All safety measures relating to COVID-19 enforced by the government/school will be followed meticulously. Due to restrictions related to COVID-19, the above tasks will be delivered virtually, using university-approved video conferencing software, because that access to children in schools is not permitted.

One session will be dedicated to tasks in English and another session will be dedicated to equivalent tasks in Arabic. The equivalent tasks in English and Arabic will be related to reading skills where your child will be asked reflect on the sounds in words, rapidly read aloud a set of letters, produce new words from root words, and identify whether words share the same root. The session will also include reading tasks in which your child will be asked to read aloud a list of words and non-words (fake words that look and sound like real words) as accurately as they can. The sessions will be audio recorded to ensure the accuracy of the scoring. With your consent, we will ask the school to provide us with copies of the diagnostic reports to ensure your child meets the inclusion criteria for this study.

You will also be contacted by the researcher through text message or email at the contact details you have provided in the consent form and you will be asked to fill out a short survey about your child's past language exposure to English and Arabic.

What are the risks and benefits of participating in the study?

The study poses no risk on the child or the parent for participating in the study. Your child may benefit from the additional practice related to reading through our tasks, which were carefully designed for children of this age and most children find them enjoyable. Your child can withdraw from the study at any time in the case he/she feels tired or upset.

What will happen to the data?

All records collected will be stored securely in a locked filing cabinet and on a password-protected computer. When the study is made available to the public, there will be no links to identify you, your child, or your school. All personally identifiable information collected for the project will be destroyed after 5 years. Any information from the study made available to fellow researchers will be anonymised. The data collected from you and your child in this study will be preserved and will be made available to other authenticated researchers in anonymised form, so that the data can be consulted on and reused by others. The results of the study may be presented at national and international conferences and published in written 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 upon request.

What happens if I/my child change our mind?

If you/your child decide to participate in this study and later change your mind, you can do so at any point in time without providing a reason and without any consequences by contacting me at the email address given above. 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 supervisors, Dr Holly Joseph (h.joseph@reading.ac.uk) and Dr Daisy Powell (d.a.powell@reading.ac.uk), at The University of Reading.

Where can I get more information?

If you would like more information, please contact Lujain AlMatrouk. Email: l.y.almatrouk@pgr.reading.ac.uk

I hope that you will agree to your child's participation in the study. If you want your child to participate, please complete the attached consent form sealed in the envelope provided and return it to your child's teacher.

Thank you for your time.

Kind regards,

Lujain AlMatrouk

Data protection for information sheets

The organisation responsible for protection of your personal information is the University of Reading (the Data Controller). Queries regarding data protection and your rights should be directed to the University Data Protection Officer at imps@reading.ac.uk, or in writing to: Information Management & Policy Services, University of Reading, Whiteknights, P O Box 217, Reading, RG6 6AH.

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If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact Lujain AlMatrouk – l.y.almatrouk@pgr.reading.ac.uk

You have certain rights under data protection law which are:

- Withdraw your consent, for example if you opted in to be added to a participant register
- Access your personal data or ask for a copy
- Rectify inaccuracies in personal data that we hold about you
- Be forgotten, that is your details to be removed from systems that we use to process your personal data
- Restrict uses of your data
- Object to uses of your data, for example retention after you have withdrawn from a study

Some restrictions apply to the above rights where data is collected and used for research purposes. You can find out more about your rights on the website of the Information Commissioners Office (ICO) at https://ico.org.u. You also have a right to complain the ICO if you are unhappy with how your data has been handled. Please contact the University Data Protection Officer in the first instance.

Parent/Carer Consent Form

To be completed by a parent or guardian who **agrees** that their child participate in the study about:

The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Researcher name: Lujain AlMatrouk

Please tick the box after each statement to confirm it has been read and agreed to. ✓

1. I have read and understand the accompanying Information Sheet relating to the above project.	
2. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.	
3. I have had explained to me what information will be collected about me, what it will be used for, who it may be shared with, how it will be kept safe, and my rights in relation to my data.	
4. I understand that participation is entirely voluntary and that I have the right to withdraw from the project any time, and that this will be without detriment.	
5. I give permission for the use of audio recordings of assessment sessions with my child.	

Parent/Carer Name: ………………………………………………………………………………

Child's Name: ………………………………………………………………………………

School Name:……………………………………………………….

Parent/Carer Signature: ………………………………………………..………………………………

Parent/Carer Phone Number or Email: ……………………………………………………

Date: ………………………………………………………..……………………

I am happy to be included on a register of research participants for the purposes of being contacted about further studies by The University of Reading *(optional).* ☐

Researcher:

Mrs. Lujain AlMatrouk

Email: l.y.almatrouk@pgr.reading.ac.uk

Supervisors:

Dr Holly Joseph

Email: h.joseph@pgr.reading.ac.uk

Dr Daisy Powell

Email: d.a.powell@reading.ac.uk

Parent/Carer Information Sheet

(Version 3- to be given to parents of experimental group 2)

Research project: The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Project team members: Lujain AlMatrouk (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)

This is an invitation for your child to participate in a research study about morphological awareness and its relationship to reading.

What is the study about?

The purpose of the study is to examine the relationship between morphological awareness and reading among bilingual students and students with LD. Morphological awareness is the awareness of the meaning components of a word. For example, being aware that if ‘er’ is added to the word ‘play,’ then the word ‘player’ is produced, and that ‘er’ usually indicates the person doing the action. This skill is important because research has shown that children use this skill when reading Arabic and English, and it is important to examine these skills in children with different reading profiles to make appropriate recommendations for their education.

Why has my child been chosen to participate in this study?

Your child has been chosen to participate in this study because he/she is between the ages 9 and 11 and has a learning disability (LD) diagnosis and is learning to read in a mostly monolingual school in Arabic.

Does my child have to participate in this study?

No. It is you and your child’s choice to participate in this study. If you would like your child to participate in this study, please fill out the attached consent form and return it to your child’s teacher.

What will happen if my child participates in this study?

With your consent, during school hours, your child will be asked to complete several tasks individually. The session will be approximately 60-80 minutes. An additional session may be scheduled, if needed, in the case where the student was not able to complete all the tasks required. The child will be given the opportunity to take several short breaks when necessary. In the case where circumstances beyond our control cause the session to stop, then the session will be rescheduled to be completed on another day. All safety measures relating to COVID-19 enforced by the government/school will be followed meticulously. Due to restrictions related to COVID-19, the above tasks will be delivered virtually, using university-approved video conferencing software, because access to children in schools is not permitted.

The session will be dedicated to tasks in Arabic. The tasks in Arabic will be related to reading skills where your child will be asked reflect on the sounds in words, rapidly read aloud a set of letters, produce new words from root words, and identify whether words share the same root. The session will also include reading tasks in which your child will be asked to read aloud a list of words and non-words (fake words that look and sound like real words) as accurately as they can. The sessions will be audio recorded to ensure the accuracy of the scoring. With your consent, we will ask the school to provide us with copies of the diagnostic reports to ensure your child meets the inclusion criteria for this study.

You will also be contacted by the researcher through text message or email at the contact details you have provided in the consent form and you will be asked to fill out a short survey relating to general information such as your educational level etc.

What are the risks and benefits of participating in the study?

The study poses no risk on the child or the parent for participating in the study. Your child may benefit from the additional practice related to reading through our tasks, which were carefully designed for children of this age and most children find them enjoyable. Your child can withdraw from the study at any time in the case he/she feels tired or upset.

What will happen to the data?

All records collected will be stored securely in a locked filing cabinet and on a password-protected computer. When the study is made available to the public, there will be no links to identify you, your child, or your school. All personally identifiable information collected for the project will be destroyed after 5 years. Any information from the study made available to fellow researchers will be anonymised. The data collected from you and your child in this study will be preserved and will be made available to other authenticated researchers in anonymised form, so that the data can be consulted on and reused by others. The results of the study may be presented at national and international conferences and published in written articles. We can send you electronic copies of these publications if you wish.

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What happens if I/my child change our mind?

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What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisors Dr Holly Joseph (h.joseph@reading.ac.uk) and Dr Daisy Powell (d.a.powell@reading.ac.uk) at The University of Reading.

Where can I get more information?

If you would like more information, please contact Lujain AlMatrouk. Email: l.y.almatrouk@pgr.reading.ac.uk

I hope that you will agree to your child's participation in the study. If you want your child to participate, please complete the attached consent form sealed in the envelope provided and return it to your child's teacher.

Thank you for your time.

Kind regards,

Lujain AlMatrouk

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If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact Lujain AlMatrouk – l.y.almatrouk@pgr.reading.ac.uk

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University of Reading

Parent/Carer Consent Form

To be completed by a parent or guardian who **agrees** that their child participate in the study about:

The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Researcher name: Lujain AlMatrouk

Please tick the box after each statement to confirm it has been read and agreed to. ✓

1. I have read and understand the accompanying Information Sheet relating to the above project.	
2. I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my participation.	
3. I have had explained to me what information will be collected about me, what it will be used for, who it may be shared with, how it will be kept safe, and my rights in relation to my data.	
4. I understand that participation is entirely voluntary and that I have the right to withdraw from the project any time, and that this will be without detriment.	
5. I give permission for the use of audio recordings of assessment sessions with my child.	

Parent/Carer Name: ……………………………………………………………………………

Child's Name: ……………………………………………………………………………

School Name:…………………………………………………………………………….

Parent/Carer Signature: ……………………………………………………………………………

Parent/Carer Phone Number or Email: ………………………………………………………

Date: ……………………………………………………………………………………

I am happy to be included on a register of research participants for the purposes of being contacted about further studies by The University of Reading *(optional).* ☐

Researcher:

Mrs. Lujain AlMatrouk

Email: l.y.almatrouk@pgr.reading.ac.uk

Supervisors:

Dr Holly Joseph

Email: h.joseph@pgr.reading.ac.uk

Dr Daisy Powell

Email: d.a.powell@reading.ac.uk

Principal Information Sheet
(Version 1- to be given to principals in bilingual schools to recruit control group and experimental group 1)

Research project: The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Project team members: Lujain AlMatrouk (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)

Dear Principal,

I am writing to invite your school to participate in a research study about morphological awareness and its relationship to reading.

What is the study about?

The purpose of the study is to examine the relationship between morphological awareness and reading among bilingual students and students with LD. Morphological awareness is the awareness of the meaning components of a word. For example, being aware that if 'er' is added to the word 'play,' then the word 'player' is produced, and that 'er' usually indicates the person doing the action. This skill is important because research has shown that children use this skill when reading Arabic and English, and it is important to examine these skills in children with different reading profiles to make appropriate recommendations for their education.

Why has this school been chosen to participate in this study?

This school was chosen because students here learn to read in Arabic and English and this school provides inclusion classes where LD students attend the same classes along with mainstream students.

Does this school have to participate in this study?

No. It is your choice to participate in this study. If you would like your school to participate in this study, please fill out the attached consent form and return it to Lujain AlMatrouk.

What will happen if the school participates in this study?

We will need a list of students attending the 4th and 5th grade inclusion classes. We will ask you to identify the students that have been diagnosed with LD from the Center of Child Evaluation and Teaching (CCET) to invite to our study. The rest of the students in the class without LD will also be invited to our study given that their teachers have reported that they do not have any major behavioural and/or learning problems. We will give you information sheets and consent forms to distribute to parents/carers of these students to invite them to our study and obtain their signed permissions. With the parents' consent, we will require copies of their diagnostic reports to ensure that they meet the inclusion criteria for this study.

With your consent and the parent's consent, during school hours, the student will be asked to complete several tasks individually. Every child will need to be seen for two sessions. Each session will be approximately 30-45 minutes each. The child will be given the opportunity to take several short breaks when necessary. In the case where circumstances beyond our control cause the session to stop, then the session will be rescheduled to be completed on another day. All safety measures relating to COVID-19 enforced by the government/school will be followed meticulously. Due to restrictions related to COVID-19, the above tasks may be delivered virtually, using university-approved video conferencing software, in the case that access to children in schools is not permitted.

One session will be dedicated to tasks in English and another session will be dedicated to equivalent tasks in Arabic. The equivalent tasks in English and Arabic will be related to reading skills where the student will be asked reflect on the sounds in words, rapidly read aloud a set of letters, produce new words from root words, and identify whether words share the same root. The session will also include reading tasks in which the student will be asked to read aloud a list of words and non-words (fake words that look and sound like real words) as accurately as they can. The sessions will be audio recorded to ensure the accuracy of the scoring.

I would also be grateful if you could provide the average time of instruction dedicated to English and Arabic per week at your school, and the date of the birth of the students to obtain his/her age.

What are the risks and benefits of participating in the study?

The study poses no risk on the child, parent, or school for participating in the study. Students could benefit from the additional practice related to reading through our tasks, which were carefully designed for children of this age and most children find them enjoyable. Students can withdraw from the study at any time in the case he/she feels tired or upset.

What will happen to the data?

All records collected will be stored securely in a locked filing cabinet and on a password-protected computer. When the study is made available to the public, there will be no links to identify parents, children, or your school. All personally identifiable information collected for the project will be destroyed after 5 years. Any information from the study made available to fellow researchers will be anonymised. The data collected for this study will be preserved and will be made available to other authenticated researchers in anonymised form, so that the data can be consulted on and reused by others. The results of the study may be presented at national and international conferences and published in written 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 consequences. If you change your mind after data collection has ended, your school's data will be discarded.

What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisors Dr Holly Joseph (h.joseph@reading.ac.uk) and Dr Daisy Powell (d.a.powell@reading.ac.uk) at The University of Reading.

Where can I get more information?

If you would like more information, please contact Lujain AlMatrouk.
l.y.almatrouk@pgr.reading.ac.uk

I hope that you will agree to participate in the study. If you do agree, please complete the attached consent form, and return it to Lujain AlMatrouk.

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.

Kind regards,

Lujain AlMatrouk

Data protection for information sheets

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If we have included any additional requests for use of your data, for example adding you to a registration list for the purposes of inviting you to take part in future studies, this will be done only with your consent where you have provided it to us and should you wish to be removed from the register at a later date, you should contact Lujain AlMatrouk – l.y.almatrouk@pgr.reading.ac.uk

You have certain rights under data protection law which are:

- Withdraw your consent, for example if you opted in to be added to a participant register
- Access your personal data or ask for a copy
- Rectify inaccuracies in personal data that we hold about you
- Be forgotten, that is your details to be removed from systems that we use to process your personal data
- Restrict uses of your data
- Object to uses of your data, for example retention after you have withdrawn from a study

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University of Reading

Principal Consent Form

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 Principal: ____

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

Researcher:

Mrs. Lujain AlMatrouk

Email: l.y.almatrouk@pgr.reading.ac.u

Supervisors:

Dr Holly Joseph

Email: h.joseph@pgr.reading.ac.uk

Dr Daisy Powell

Email: d.a.powell@reading.ac.uk

Principal Information Sheet
(Version 2- to be given to principal in monolingual LD school to recruit experimental group 2)

Research project: The relationship between morphological awareness and reading among bilingual students and students with a learning disability (LD).

Project team members: Lujain AlMatrouk (researcher), Dr Holly Joseph and Dr Daisy Powell (supervisors)

Dear Principal,

I am writing to invite your school to participate in a research study about morphological awareness and its relationship to reading.

What is the study about?

The purpose of the study is to examine the relationship between morphological awareness and reading among bilingual students and students with LD. Morphological awareness is the awareness of the meaning components of a word. For example, being aware that if 'er' is added to the word 'play,' then the word 'player' is produced, and that 'er' usually indicates the person doing the action. This skill is important because research has shown that children use this skill when reading Arabic and English, and it is important to examine these skills in children with different reading profiles to make appropriate recommendations for their education.

Why has this school been chosen to participate in this study?

This school was chosen because students here have been diagnosed with LD and learn to read in mostly Arabic.

Does this school have to participate in this study?

No. It is your choice to participate in this study. If you would like your school to participate in this study, please fill out the attached consent form and return it to Lujain AlMatrouk.

What will happen if the school participates in this study?

We will need a list of students attending the 4th and 5th grade to invite to our study. We will give you consent forms to distribute to parents/carers of these students to invite them to our study and obtain their signed permissions. With the parents' permission, we will also require copies of their diagnostic reports to ensure that they meet the inclusion criteria for this study.

With your consent and the parent's consent, during school hours, the student will be asked to complete several tasks individually. Every child will need to be seen for one session. Each session will be approximately 30-45 minutes each. The child will be given the opportunity to take several short breaks when necessary. In the case where circumstances beyond our control cause the session to stop, then the session will be rescheduled to be completed on another day. All safety measures relating to COVID-19 enforced by the government/school will be followed meticulously. Due to restrictions related to COVID-19, the above tasks may be delivered virtually, using university-approved video conferencing software, in the case that access to children in schools is not permitted.

The tasks will be in Arabic and will be related to reading skills where the student will be asked reflect on the sounds in words, rapidly read aloud a set of letters, produce new words from root words, and identify whether words share the same root. The session will also include reading tasks in which the student will be asked to read aloud a list of words and non-words (fake words that look and sound like real words) as accurately as they can. The sessions will be audio recorded to ensure the accuracy of the scoring.

I would also be grateful if you could provide the average time of instruction dedicated to English and Arabic per week at your school.

What are the risks and benefits of participating in the study?

The study poses no risk on the child, parent, or school for participating in the study. Students could benefit from the additional practice related to reading through our tasks, which were carefully designed for children of this age and most children find them enjoyable. Students can withdraw from the study at any time in the case he/she feels tired or upset.

What will happen to the data?

All records collected will be stored securely in a locked filing cabinet and on a password-protected computer. When the study is made available to the public, there will be no links to identify parents, children, or your school. All personally identifiable information collected for the project will be destroyed after 5 years. Any information from the study made available to fellow researchers will be anonymised. The data collected for this study will be preserved and will be made available to other authenticated researchers in anonymised form, so that the data can be consulted on and reused by others. The results of the study may be presented at national and international conferences and published in written articles. We can send you electronic copies of these publications if you wish.

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You can change your mind at any time without any consequences. If you change your mind after data collection has ended, your school's data will be discarded.

What happens if something goes wrong?

In the unlikely case of concern or complaint, you can contact my supervisors Dr Holly Joseph (h.joseph@reading.ac.uk) and Dr Daisy Powell (d.a.powell@reading.ac.uk) at The University of Reading.

Where can I get more information?

If you would like more information, please contact Lujain AlMatrouk.
l.y.almatrouk@pgr.reading.ac.uk

I hope that you will agree to participate in the study. If you do agree, please complete the attached consent form, and return it to Lujain AlMatrouk.

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.

Kind regards,

Lujain AlMatrouk

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Principal Consent Form

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 Principal: ____

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: ……………………………………………………………………………………

Student Information Sheet

Research Project

Do children who learn to read in two languages read differently to children who read only one?

Institute of Education
London Road Campus
RG1 5EX

Research Team
Mrs. Lujain AlMatrouk
Dr Holly Joseph
Dr Daisy Powell

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.

Your parents and principal have been sent a letter to ask for their permission for you to be part of this project. They are happy for you to help me.
Are you happy to help me with my project?

I want to check with you before we start the tasks.

If you have any questions, please speak to your class teacher or you can email me, Lujain AlMatrouk at l.y.almatrouk@pgr.reading.ac.uk

Why am I invited to help with this project?

Because you are learning to read in English and Arabic

Will anyone know my answers?

My team and I only will know your answers. I will not tell your parents or your school anything about your answers.

What will I have to do?

During school time, I will come and see you at school for 60-80 minutes for two days. We can take several short breaks. You will be asked say words and take away smaller parts of the words, read letters as fast as you can, come up with new words from other words, and tell me if words are related to each other. I will ask you to read a list of words and fake words in English and Arabic.

Do I have to help you?

No, even if you change your mind during the study, you can stop helping me any time without giving a reason why. Tell your teacher or parent to tell me that you do not want to help me with my project anymore.

Will it be good for me to help you?

My tasks may be fun for you. Some people learn to read in only English or Arabic. Your answers will help me to understand more about children who read in both languages.

(Version 1- to be given to children in control group)

<u>Student Information Sheet</u>

Research Project

Do children who learn to read in two languages read differently to children who read only one?

Institute of Education
London Road Campus
RG1 5EX

Research Team
Mrs. Lujain AlMatrouk
Dr Holly Joseph
Dr Daisy Powell

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.

Your parents and principal have been sent a letter to ask for their permission for you to be part of this project. They are happy for you to help me.
Are you happy to help me with my project?

I want to check with you before we start the tasks.

If you have any questions, please speak to your class teacher or you can email me, Lujain AlMatrouk at l.y.almatrouk@pgr.reading.ac.uk

Why am I invited to help with this project?
Because you are learning to read in English and Arabic and we are interested in looking at different profiles of strengths and weaknesses in reading

Will anyone know my answers?

My team and I only will know your answers. I will not tell your parents or your school anything about your answers.

What will I have to do?

During school time, I will come and see you at school for 60-80 minutes for two days. We can take several short breaks. You will be asked say words and take away smaller parts of the words, read letters as fast as you can, come up with new words from other words, and tell me if words are related to each other. I will ask you to read a list of words and fake words in English and Arabic.

Do I have to help you?

No, even if you change your mind during the study, you can stop helping me any time without giving a reason why. Tell your teacher or parent to tell me that you do not want to help me with my project anymore.

Will it be good for me to help you?

My tasks may be fun for you. Some people learn to read in only English or Arabic. Your answers will help me to understand more about children who read in both languages.

(Version 2- to be given to children in experimental group 1)

Student Information Sheet

Research Project

Do children who learn to read in two languages read differently to children who read only one?

Institute of Education
London Road Campus
RG1 5EX

Research Team
Mrs. Lujain AlMatrouk
Dr Holly Joseph
Dr Daisy Powell

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.

Your parents and principal have been sent a letter to ask for their permission for you to be part of this project. They are happy for you to help me.
Are you happy to help me with my project?

I want to check with you before we start the tasks.

If you have any questions, please speak to your class teacher or you can email me, Lujain AlMatrouk at l.y.almatrouk@pgr.reading.ac.uk

Why am I invited to help with this project?
Because you are learning to read in Arabic and we are interested in looking at different profiles or strengths and weaknesses in reading

Will anyone know my answers?

My team and I only will know your answers. I will not tell your parents or your school anything about your answers.

What will I have to do?

During school time, I will come and see you at school for 60-80 minutes for one day. We can take several short breaks. You will be asked say words and take away smaller parts of the words, read letters as fast as you can, come up with new words from other words, and tell me if words are related to each other. I will ask you to read a list of words and fake words in Arabic.

Do I have to help you?

No, even if you change your mind during the study, you can stop helping me any time without giving a reason why. Tell your teacher or parent to tell me that you do not want to help me with my project anymore.

Will it be good for me to help you?

My tasks may be fun for you. Your answers will help me to understand more about children who read in Arabic with different profiles of strengths and weaknesses in reading.

(Version 3- to be given to children in experimental group 2)

(Morphological tasks)

If the first word comes from the second say ‘yes’
If the first word does not come from the say ‘no’

Sample 1:	**teacher**	**teach**	**YES**	**NO**
Sample 2:	**single**	**sing**	**YES**	**NO**
Sample 3:	**liver**	**live**	**YES**	**NO**
Sample 4:	**climber**	**climb**	**YES**	**NO**

winter	win	YES	NO
thinker	think	YES	NO
message	mess	YES	NO
belly	bell	YES	NO
mother	moth	YES	NO
rainy	rain	YES	NO
laughter	laugh	YES	NO
imaginary	imagine	YES	NO
catch	cat	YES	NO
summary	sum	YES	NO
carpet	car	YES	NO
twelfth	twelve	YES	NO
painful	pain	YES	NO
decision	decide	YES	NO
pumpkin	pump	YES	NO
fifty	five	YES	NO
criminal	crime	YES	NO
early	ear	YES	NO
candy	can	YES	NO
butter	butt	YES	NO

We are going to play a word game. I am going to say two words that are related to each other. I want you to think about how they are related. I will then say a third word. I want you to tell me the word that comes next. Let's try one.
If I say walk and then I say walker; then I say teach, so then I should say …?''. If the child did not respond correctly (teacher), the experimenter explains how walk and walker were alike, and then how teach and teacher were alike the same way:

teacher is the right answer. This is one walk and walker is the name for someone who walks. So this is one teach, and *teacher* is the name for someone who teaches. **The same procedure is followed for the second example.**

Practice examples:

walk: walker:: teach: *teacher*

sleep: sleepy:: cloud: *cloudy*

Test items:

1 mess: messy:: fun: *funny*

2 paint: painter:: bake: *baker*

3 anger: angry:: sun: *sunny*

4 teach: teacher:: work: *worker*

5 high: height:: deep: *depth*

6 decide: decision:: act: *action*

7 science: scientist:: art: *artist*

8 long: length:: wide: *width*

9 warm: warmth:: strong: *strength*

10 magic: magician:: music: *musician*

We are going to play a word game.
I am going to say two words that are related to each other. I want you to think about how they are related.

I will then say a third word. I want you to write the word that comes next. The word that completes the pattern is a funny word that you have not heard before. Just remember to think about the pattern of the first two words and have a go.

Let's try one.

Practice examples:

drive	driver	snig	___________
sad	sadness	prist	__________

spot	spotty	quock	___________
bake	baker	zab	___________
dust	dusty	roosic	___________
scotland	scottish	korbland	___________
tired	tiredness	luggy	___________
imagine	imagination	lampete	___________
cartoon	cartoonist	frickary	___________
kind	kindness	fick	___________
funny	funnily	claidy	___________
avoid	avoidable	zon	___________

(For Arabic Standardized Tests)

Undertaking

I, the undersigned / Lujain AlMatrouk
carrying a civil card number / 289032500894
working at/ The University of Reading
in the state of/ The United Kingdom
undertake to maintain the confidentiality of tests owned by the [redacted]), and to use them only for the purpose of scientific research. I will not leak any of these tests in any form and will acknowledge the copyright of the Center in the documentation of my research.

Date: 01/09/2019
Name: Lujain AlMatrouk

Signature:

Information Management and Policy Services

University of Reading

DATA PROTECTION DECLARATION FOR ETHICAL APPROVAL

This document can be used to provide assurances to your ethics committee where confirmation of data protection training and awareness is required for ethical approval.

By signing this declaration I confirm that:

- I have read and understood the requirements for data protection within the *Data Protection for Researchers* document located here:

  http://www.reading.ac.uk/web/files/imps/Data_Protection_for_Researchers__Aug_18.v1.pdf

- I have asked for advice on any elements that I am *unclear on* prior to submitting my ethics approval request, either from my supervisor, or the data protection team at: imps@reading.ac.uk

- I understand that I am responsible for the secure handling, and protection of, my research data

- I know who to contact in the event of an information security incident, a data protection complaint or a request made under data subject access rights

RESEARCHER TO COMPLETE

Project/Study Title: The relationship between morphological awareness and reading accuracy and fluency among bilingual Arabic-English mainstream and dyslexic children in Kuwait

NAME	STUDENT ID NUMBER	DATE
Lujain AlMatrouk	22836465	22/07/2020

SUPERVISOR SIGNATURE

Note for supervisors: Please verify that your student has completed the above actions

NAME	STAFF ID NUMBER	DATE
Daisy Powell		28/08/2020

Submit your completed signed copy to your ethical approval committee.

Copies to be retained by ethics committee.

VERSION	KEEPER	REVIEWED	APPROVED BY	APPROVAL DATE
1.0	IMPS	Annually	IMPS	

Appendix 2

Arabic reading accuracy word items from Saiegh-Haddad and Taha's (2017) study

Voweled items

1. ضَبَاب
2. صَغِير
3. كَبْش
4. استَجْمَعَ
5. تَقَاتَلَ
6. جَرَس
7. ضَجِيج
8. عَصِير
9. دُرْج
10. تَجَاهَلَ
11. تَدَرَّبَ
12. بُخَار
13. قَارِب
14. رَطِب
15. حَبْس
16. اسْتَمْتَعَ

17. اسـتَدَارَ
18. عَجُوز
19. ضَعِيف
20. طَابَة
21. نَبْع
22. انتَفَخَ
23. انْتَقَدَ
24. هَوَاء
25. قَرِيب
26. ظَلام
27. جُرْح
28. تَبَدَّلَ
29. انْتَصَبَ
30. فَرَاش

Unvowled items

1. عضو
2. صاروخ
3. بحر
4. استكمل
5. استقرض
6. خشب
7. قمر
8. مطرب
9. ثلج
10. تعلم
11. تضامن
12. حزين
13. قليل
14. أصفر
15. نبع
16. تشجع
17. تشاجر
18. أمير
19. اضراب

20. عصفور
21. حرب
22. تتابع
23. قلم
24. ظهور
25. جسم
26. اندفع
27. كثير
28. عجين
29. استصرخ
30. انتصر

Nonword items

1.ضُبَاش

2.صَارِش

3.بَمْل

4.استَعْفَلَ

5.اسْتَضْرَمَ

6.تَرَاطَمَ

7.بِلام

8.تَلَمَّشَ

9.فَيون

10. زَشْل

11. بُطْرُم

12. ضَبَف

13. قَامِش

14. ظَابُوب

15. ثَالوب

16. خَفْم

17. إختَنَفَ

18. إنْتَرَصَ
19. تَرَطَّمَ
20. تَفَاشَلَ
21. بَزْل
22. مَفْهَل
23. ظَامِر
24. ضَرِيم
25. قَبِيش
26. كَابُوز
27. طَمِيج
28. عَفْز
29. استَدْلَفَ
30. انْتَضَلَ

Appendix 3

Arabic reading fluency word items from Tibi (2016)'s study

عَزيمَتُك	أَتَذَكَّر	في
لِيُعالِج	أَعْجَبَتْني	أَنا
اسْتَفَدْت	مَسْرَحِيّة	كانَ
يُناقِش	أَزْهار	هُوَ
يُحَلِّلها	عِبارَتَيْن	اللّه
اشْترى	اخْتِراع	الصَّف
اسْتَمَعْتْ	شاطِئْ	ماذا
القَرَوِيّين	الآخَرين	الكِتاب
مُبْصِر	كَثير	الّذي
لاحَظْنا	يَحْفَظُها	أَقْرَأ
المُسْتَشْفَيات	دائِرة	الأَطْفال
يَتَفاءَل	الرِّياضِيّة	الأَرْض
الرَّحّالَتان	إِضاءة	تَحْتَها
الإيماءات	الجائِعة	ذلِكَ
يُنْشِدون	تَنْبَعِث	مُعَلِّمي

المُلَوَّنة	زُمَلائي	المُتَفَوِّقون
سَيَفْعَل	وَظيفَتُها	شَلّالات
الفَتى	قَرَّرَتْ	وُجوهُهُمْ
الأَسْئِلة	خَمْسين	ضَوْء
المَدينة	المُتَسابِقون	صائِمين
بِطاقة	التَخَصُّصي	أَضْحى
المَفاهيم	أَتَأَمَل	الخَضْراوات
عَنْكَبوت	مُسْتَطيل	قارِئْ
الصِّحّة	المُؤَلِّفون	سَيُكَرِّرْنَ
رَئيس	رَأْسِيَّتان	لَيَبيعَها
يَسْتَخْدِم	حَياتُنا	اصْبِروا

Appendix 4
Pre-pilot Morphological awareness tasks

Morphological awareness judgement task (written)

Present the items visually for the child to look at while the examiner reads the items to the child.

You see 10 pairs of words. After each pair you see the words 'YES' and 'NO'. For each pair of words say 'YES' if you think the words are related to each other. That is, say 'YES' if you think the first word comes from the second word. Say 'NO' if you think that the words are not related. Now look at the examples. The first example is 'teacher-teach'. 'YES' is the correct answer because 'teacher' is the person who 'teaches'. They are related words. The second example is 'single-sing'. 'NO' is the correct answer because single has nothing to do with singing. It's just by accident that they start with the same letters. The third example is 'Friday - fry. 'NO' is the correct answer because Friday has nothing to do with frying. It's just by accident that the words start with the same sounds. The last example is 'singer – sing'. 'YES' is the correct answer because a singer is a person who sings. So the words are related. Do you have any questions about what you are supposed to do? I will read the words to you. After I read each pair, say 'YES' or 'NO'.

If the first word comes from the second, say yes

If the first word does not come from the second, say no

Sample 1:	**teacher**	**teach**	**YES**	**NO**
Sample 2:	**single**	**sing**	**YES**	**NO**
Sample 3:	**Friday**	**fry**	**YES**	**NO**
Sample 4:	**singer**	**sing**	**YES**	**NO**

1 winter	win	YES	NO
2 thinker	think	YES	NO
3 message	mess	YES	NO
4 belly	bell	YES	NO
5 mother	moth	YES	NO
6 rainy	rain	YES	NO
7 laughter	laugh	YES	NO
8 imaginary	imagine	YES	NO
9 catch	cat	YES	NO
10 summary	sum	YES	NO

Morphological awareness judgement task (oral)

Now we're going to do the exact same thing but instead of seeing the words I will say them to you and I want you say 'YES' if you think the first word comes from the second word. Say 'NO' if you think that the words are not related. Do you have any questions about what you are supposed to do? I will read the words to you. After I read each pair, say 'YES' or 'NO'.

1 carpet	car	YES	NO
2 twelfth	twelve	YES	NO
3 painful	pain	YES	NO
4 decision	decide	YES	NO
5 pumpkin	pump	YES	NO
6 fifty	five	YES	NO
7 criminal	crime	YES	NO
8 early	ear	YES	NO
9 candy	can	YES	NO
10 butter	butt	YES	NO

Morphological awareness analogy task (oral)

We are going to play a word game. I am going to say two words that are related to each other. I want you to think about how they are related. I will then say a third word. I want you to tell me the word that comes next. Sometimes the word that completes the pattern might sound different to the example. Sometimes the word that completes the pattern might be a funny word that you have not heard before, or might sound different to the example. Just remember to think about the pattern of the first two words and have a go.

Let's try one

If I say walk and then I say walker; then I say teach, so then I should say …?". If the child did not respond correctly (teacher), the experimenter explains how walk and walker were alike, and then how teach and teacher were alike the same way:

teacher is the right answer. The first one is walk and walker is the name for someone who walks. So this is one teach, and *teacher* is the name for someone who teaches.

The same procedure is followed for the second and third example.

Example 2

Example 3:

Sometimes the words sound different. We can describe something as beautiful, but we can also describe something as dirty.

Now we are going to do some more. Do you have any questions before we begin?

Stop when the participant makes four consecutive errors

Practice examples:

walk: walker:: teach: *teacher*

sad: sadness :: prist: pristness

beauty : beautiful :: dirt : *dirty*

Test items:

1 mess: messy:: fun: *funny*

2 paint: painter:: bake: *baker*

3 Act : active :: trelate

4 high: height:: deep: *depth*

5 drive : driver:: nazz :

6 mud : muddy :: blost :

7 decide: decision:: act: *action*

8 kind :kindness :: fick :

9 science: scientist:: art: *artist*

10 long: length:: wide: *width*

11 imagine : imagination :: lampete :

12 warm: warmth :: strong: *strength*

13 cartoon : cartoonist :: frickary :

14 magic: magician:: music: *musician*

15 Allow: allowance :: klate :

16 Bag : baggage :: streck :

Morphological awareness analogy task (written)

We are going to play the same word game. I am going to read to you two words that are related to each other. I want you to think about how they are related. I will then read a third word. I want you to say the word that comes next.

Sometimes the word that completes the pattern might be a funny word that you have not heard before, or might sound different to the example. Just remember to think about the pattern of the first two words and have a go.

Let's try one.

examples

Now we are going to do some more. Do you have any questions before we begin?

Stop when the participant makes four consecutive errors

Practice examples:

play	player	wug	__________
sleep	sleepy	cloud	__________
enjoy	enjoyment	splow	__________

1 spot	spotty	quock	__________
2 bake	baker	zab	__________
3 anger	angry	sun	__________
4 scotland	scottish	korbland	__________
5 teach	teacher	work	__________
6 dust	dusty	roosic	__________
7 change	changeable	wash	__________
8 tired	tiredness	luggy	__________
9 stupid	stupidity	dark	__________
10 poison	poisonous	danger	__________
11 funny	funnily	claidy	__________
12 avoid	avoidable	zon	__________
13 real	reality	electric	__________
14 magnet	magnetic	wrama	__________
15 guard	guardian	library	__________
16 participate	participation	add	__________

Morphological awareness judgement task (written)

شوف في كلمتين يمهم نعم و لا عقب ما اقرا الكلمتين ابيك تقولي

نعم إذا كانت الكلمتين تابعه لنفس الأصل

لا إذا مو تابعين لنفس الأصل

شنو يعني نفس الأصل

مثلا جلوس و مجلس يتبعون نفس الأصل لان الكلمتين ايون من الأصل ج ل س فعشان جذي الجواب نعم

لكن الكلمتين جلس و مقعد مو من نفس الأصل لان جلس تيي من ج ل س و مقعد تيي من ق ع د

المثال 3 و 4

عندك أي سؤال عن شنو لازم نسوي؟ الحين راح اقرا الكلمات قولي عقب كل اثنين نعم اذا نفس الأصل و لا اذا مو نفس الاصل

مثال:	**جلوس**	**مجلس**	**نعم**	**لا**
مثال:	**جلس**	**مقعد**	**نعم**	**لا**
مثال:	**رقص**	**راقص**	**نعم**	**لا**
مثال:	**رقص**	**أغاني**	**نعم**	**لا**

1 مَكْتب	كِتاب	نعم	لا
2 صُورَة	مُصوّر	نعم	لا
3 طَبيب	مَرَض	نعم	لا
4 مُزَارِع	زَرْع	نعم	لا
5 مَنجَرَة	خَشَب	نعم	لا
6 مَطعَم	طبّاخ	نعم	لا
7 حَرارَة	مِيزان	نعم	لا
8 مَدرَسَة	درس	نعم	لا
9 صُعوبَة	استَصعَب	نعم	لا
10 سَوائل	مِياه	نعم	لا

Morphological awareness judgement task (oral)

الحين راح نسوي نفس الشي بس بدال ما تشوف الكلمات راح اقولهم

الحين راح اقول الكلمات قولي عقب كل اثنين نعم اذا نفس الأصل و لا اذا مو نفس الأصل

عندك أي سؤال عن شنو لازم نسوي؟

1 حاسوب	**حِساب**	نعم	لا
2 عِنَب	**عُنقود**	نعم	لا
3 بَرْد	**بارِد**	نعم	لا
4 مَحْكَمة	**عَدْل**	نعم	لا
5 مَصْنع	**صانِع**	نعم	لا
6 مُرَاقَبة	**بُرْج**	نعم	لا
7 مَركَبة	**راكِب**	نعم	لا
8 عَمَل	**عامِل**	نعم	لا
9 جَو	**فَضاء**	نعم	لا
10 مُهَرّج	**سيرك**	نعم	لا

Morphological awareness analogy task (oral)

راح اقولك كلمتين متعلقه بالثانيه ابيك تفكر شلون اهمه متعلقين ببعض و بعدين بقول كلمة ثالثة لازم تقولي شنو الكلمه اللي وراها. مثلا اذا قلت رَقَصَ بعدين قلت راقِصْ بعدين قلت صَبَرَ بعدين لازم تقول ....؟ اذا ما فهم الطالب يتم الشرح.

مو صح

قلنا اول شي رقص بعدين راقص الراقص اهوه اللي يرقص صح بعدين قلنا صبر شنو نقول عقب صابر اهوه اللي يصبر

في بعض الكلمات موصجيه بس حاول تفكر بالعلاقه بين الكلمتين الاوليين و بعدين حاول مع الكلمة ال مو صجيه

نفس الشي للمثال الثاني.

الأمثلة:

رَقَصَ : راقِصْ :: صَبَرَ: صابِرْ

صَمَّمَ : مُصَمِّمْ :: عَلَّمَ : مُعَلِّمْ

نظر: مَنْظر:: عصق ::

الأسئلة:

1طويل : طول::عريض: عرض

2 قوة : قوي::ضعف: ضعيف

3

from Mahfoudhi et al.'s (2012) Children's standardized orthographic processing and morphological awareness test

4 ينشد : نشيد::يهرب: هروب

5

from Mahfoudhi et al.'s (2012) Children's standardized orthographic processing and morphological awareness test

6 مكر : مكّار ::

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test (non-word production sub-test)

7 يخاطر: مخاطرة::يراقب: مراقبة

8

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test

9 يركب : راكب::يعمل: عامل

10يتأسف : متأسف::يندهش: مندهش

11 عامل : معاملة::دافع: مدافعة

12 يمارس : ممارسة ::

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test (non-word production sub-test)

13 جاوب: إجابة ::امتحن: امتحان

14

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test

15

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test

16 شكر : مشكور ::

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test (non-word production sub-test)

Morphological awareness analogy task (written)

راح اقرالك كلمتين متعلقه بالثانيه ابيك تفكر شلون اهمه متعلقين ببعض

و بعدين في كلمة مرات صحيه مرات مو صحيه ابيك تقول او تكتب يمها كلمه على نفس الوزن مالت الكلمه الثانيه الصحيه

مثلا اذا قلت رسم بعدين قلت مرسوم و بعدين قلت كلمة موصحية مثل ف خ ج شنو بعدين لازم اكتب؟

صح

خنجرب واحدة ثانية

مو صح

Cards provided in the standardized test were used to explain the concept before proceeding to test items.

الأمثلة:

ر س م	مَرْسومْ	ف خ ج	__________
ش ك ر	شاكِر	ز م ج	__________
ك ت ب	مَكْتَبة	د ر س	__________

1				________
2				________
3	ذ ه ب	ذاهِب	س م ع	________
4				________
5	ح ف ظ	مَحْفَظة	غ س ل	________
6		دِراسة		________
7	س ب ح	سبَّاح		________
8		مَدْفوع	ر ب ط	________
9				________
10	ف ع ل	انْفِعالْ		________
				________
12		واصِل		________
13		مَشْكور		________
14	ك ت ب	مَكْتَب		________
15	ن ج ر	نِجارة		________
16				________

Appendix 5

Post-pilot Morphological awareness tasks

Morphological awareness judgement task (written)

Examples

Present the items visually for the child to look at while the examiner reads the items to the child.

You see 10 pairs of words. After each pair you see the words 'YES' and 'NO'. For each pair of words say 'YES' if you think the words are related to each other. That is, say 'YES' if you think the first word comes from the second word. Say 'NO' if you think that the words are not related. Now look at the examples. The first example is 'teacher-teach'. 'YES' is the correct answer because 'teacher' is the person who 'teaches'. They are related words. The second example is 'single-sing'. 'NO' is the correct answer because single has nothing to do with singing. It's just by accident that they start with the same letters. The third example is 'Friday - fry. 'NO' is the correct answer because Friday has nothing to do with frying. It's just by accident that the words start with the same sounds. The last example is 'singer – sing'. 'YES' is the correct answer because a singer is a person who sings. So the words are related. Do you have any questions about what you are supposed to do? I will read the words to you. After I read each pair, say 'YES' or 'NO'.

If the first word comes from the second, say yes

If the first word does not come from the second, say no

Sample 1:	**teacher**	**teach**	**YES**	**NO**
Sample 2:	**single**	**sing**	**YES**	**NO**
Sample 3:	**Friday**	**fry**	**YES**	**NO**
Sample 4:	**singer**	**sing**	**YES**	**NO**

1 winter	win	YES	NO
2 depth	deep	YES	NO
3 message	mess	YES	NO
4 belly	bell	YES	NO
5 mother	moth	YES	NO
6 permission	permit	YES	NO
7 laughter	laugh	YES	NO
8 imaginary	imagine	YES	NO
9 catch	cat	YES	NO
10 summary	sum	YES	NO

Morphological awareness judgement task (oral)

Now we're going to do the exact same thing but instead of seeing the words I will say them to you and I want you say 'YES' if you think the first word comes from the second word. Say 'NO' if you think that the words are not related. Do you have any questions about what you are supposed to do? I will read the words to you. After I read each pair, say 'YES' or 'NO'.

If the first word comes from the second, say yes

If the first word does not come from the second, say no

Sample 1:	**teacher**	**teach**	**YES**	**NO**
Sample 2:	**single**	**sing**	**YES**	**NO**
Sample 3:	**Friday**	**fry**	**YES**	**NO**
Sample 4:	**singer**	**sing**	**YES**	**NO**

1 carpet	car	YES	NO
2 corner	corn	YES	NO
3 painful	pain	YES	NO
4 decision	decide	YES	NO
5 pumpkin	pump	YES	NO
6 education	educate	YES	NO
7 criminal	crime	YES	NO
8 early	ear	YES	NO
9 health	heal	YES	NO
10 mention	men	YES	NO

Morphological awareness analogy task (oral)

We are going to play a word game. I am going to say two words that are related to each other. I want you to think about how they are related. I will then say a third word. I want you to tell me the word that comes next. Sometimes the word that completes the pattern might sound different to the example. Sometimes the word that completes the pattern might be a funny word that you have not heard before, or might sound different to the example. Just remember to think about the pattern of the first two words and have a go.

Let's try one

If I say walk and then I say walker; then I say teach, so then I should say …?". If the child did not respond correctly (teacher), the experimenter explains how walk and walker were alike, and then how teach and teacher were alike the same way:

teacher is the right answer. The first one is walk and walker is the name for someone who walks. So this is one teach, and *teacher* is the name for someone who teaches.

The same procedure is followed for the second and third example.

Example 2

Example 3:

Sometimes the words sound different. We can describe something as beautiful, but we can also describe something as dirty.

Now we are going to do some more. Do you have any questions before we begin?

Stop when the participant makes four consecutive errors

Practice examples:

walk	walker	teach	______
sad	sadness	prist	______
beauty	beautiful	dirt	______

1 mess	messy	fun	______
2 drive	driver	nazz	______
3 mud	muddy	blost	______
4 kind	kindness	fick	______
5 science	scientist	art	______
6 long	length	wide	______
7 magic	magician	music	______
8 warm	warmth	strong	______
9 allow	allowance	klate	______
10 bag	baggage	streck	______

Morphological awareness analogy task (written)

We are going to play the same word game. I am going to read to you two words that are related to each other. I want you to think about how they are related. I will then read a third word. I want you to write or say the word that comes next.

Sometimes the word that completes the pattern might be a funny word that you have not heard before, or might sound different to the example. Just remember to think about the pattern of the first two words and have a go.

Let's try one.

examples

Now we are going to do some more. Do you have any questions before we begin?

Stop when the participant makes four consecutive errors

Practice examples:

play	player	wug	________
sleep	sleepy	cloud	________
enjoy	enjoyment	splow	________

1 spot	spotty	quock	________
2 bake	baker	zab	________
3 change	changeable	wash	________
4 tired	tiredness	luggy	________
5 stupid	stupidity	dark	________
6 funny	funnily	claidy	________
7 avoid	avoidable	zon	________
8 real	reality	electric	________
9 guard	guardian	library	________
10 participate	participation	add	________

Morphological awareness judgement task (written)

شوف في كلمتين يمهم نعم و لا عقب ما اقرا الكلمتين ابيك تقولي

نعم إذا كانت الكلمتين تابعه لنفس الأصل

لا إذا مو تابعين لنفس الأصل

شنو يعني نفس الأصل

مثلا جلوس و مجلس يتبعون نفس الأصل لان الكلمتين ايون من الأصل ج ل س فعشان جذي الجواب نعم

لكن الكلمتين جلس و مقعد مو من نفس الأصل لان جلس تيي من ج ل س و مقعد تيي من ق ع د

المثال 3 و 4

عندك أي سؤال عن شنو لازم نسوي؟ الحين راح اقرا الكلمات قولي عقب كل اثنين نعم اذا نفس الأصل و لا اذا مو نفس الاصل

مثال:	**جلوس**	**مجلس**	**نعم**	**لا**
مثال:	**جلس**	**مقعد**	**نعم**	**لا**
مثال:	**رقص**	**راقص**	**نعم**	**لا**
مثال:	**رقص**	**أغاني**	**نعم**	**لا**

1 مَكْتب	**كِتاب**	**نعم**	**لا**
2 صُورَة	**مُصوّر**	**نعم**	**لا**
3 طَبيب	**مَرَض**	**نعم**	**لا**
4 مُزَارِع	**زَرْع**	**نعم**	**لا**
5 مَنجَرَة	**خَشَب**	**نعم**	**لا**
6 مَطعَم	**طبّاخ**	**نعم**	**لا**
7 حَرارَة	**مِيزان**	**نعم**	**لا**
8 مَدرَسَة	**درس**	**نعم**	**لا**
9 صُعوبَة	**استَصعَب**	**نعم**	**لا**
10 سَوائل	**مِياه**	**نعم**	**لا**

Morphological awareness judgement task (oral)

الحين راح نسوي نفس الشي بس بدال ما تشوف الكلمات راح اقولهم

الحين راح اقول الكلمات قولي عقب كل اثنين نعم اذا نفس الأصل و لا اذا مو نفس الأصل

عندك أي سؤال عن شنو لازم نسوي؟

1 حاسوب	**حِساب**	نعم	لا
2 عِنَب	**عُنقود**	نعم	لا
3 بَرْد	**بارِد**	نعم	لا
4 مَحْكَمة	**عَدْل**	نعم	لا
5 مَصْنع	**صانِع**	نعم	لا
6 مُرَاقَبة	**بُرْج**	نعم	لا
7 مَركَبة	**راكِب**	نعم	لا
8 عَمَل	**عامِل**	نعم	لا
9 جَو	**فَضاء**	نعم	لا
10 مُهَرِّج	**سيرك**	نعم	لا

Morphological awareness analogy task (oral)

الحين راح نسوي نفس الشي بس بدال ما تشوف الكلمات راح اقولهم

راح اقولك كلمتين متعلقه بالثانيه ابيك تفكر شلون اهمه متعلقين ببعض و بعدين بقول كلمة ثالثة لازم تقولي شنو الكلمه اللي وراها. مثلا اذا قلت رَقَصَ بعدين قلت راقِصْ بعدين قلت صَبَرَ بعدين لازم تقول ....؟ اذا ما فهم الطالب يتم الشرح.

مو صح

قلنا اول شي رقص بعدين راقص الراقص اهوه اللي يرقص صح بعدين قلنا صبر شنو نقول عقب صابر اهوه اللي يصبر

في بعض الكلمات موصجيه بس حاول تفكر بالعلاقه بين الكلمتين الاوليين و بعدين حاول مع الكلمة ال مو صجيه

نفس الشي للمثال الثاني.

الأمثلة:

رَقَصَ : راقِصْ :: صَبَرَ: صابِرْ

صَمَّمَ : مُصَمِّمْ :: عَلَّمَ : مُعَلِّمْ

نظر: مَنْظر:: عصق ::

الأسئلة:

1 يركب : راكب::يعمل: عامل

2 قوة : قوي::ضعف: ضعيف

3

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test

4 مكر : مكّار ::

from Mahfoudhi et al.’s (2012) Children's standardized orthographic processing and morphological awareness test (non-word production sub-test)

5 يخاطر: مخاطرة::يراقب: مراقبة

6 يتأسف : متأسف::يندهش: مندهش

7 جاوب: إجابة ::امتحن: امتحان

8

from Mahfoudhi et al.'s (2012) Children's standardized orthographic processing and morphological awareness test

9

from Mahfoudhi et al.'s (2012) Children's standardized orthographic processing and morphological awareness test

10 شكر : مشكور ::

from Mahfoudhi et al.'s (2012) Children's standardized orthographic processing and morphological awareness test (non-word production sub-test)

Morphological awareness analogy (written)

راح اقرالك كلمتين متعلقه بالثانيه ابيك تفكر شلون اهمه متعلقين ببعض

و بعدين في كلمة مرات صجيه مرات مو صجيه ابيك تكتب يمها كلمه على نفس الوزن مالت الكلمه الثانيه الصجيه

مثلا اذا قلت رسم بعدين قلت مرسوم و بعدين قلت كلمة موصجية مثل ف خ ج شنو بعدين لازم اكتب؟

صح

خنجرب واحدة ثانية

مو صح

Cards provided in the standardized test were used to explain the concept before proceeding to test items.

الأمثلة:

ر س م	مَرْسومْ	ف خ ج	__________
ش ك ر	شاكِر	ز م ج	__________
ك ت ب	مَكْتَبة	د ر س	__________

1				
2				
3	ذ ه ب	ذاهِب	س م ع	
4				
5	ح ف ظ	مَحْفَظة	غ س ل	
6		دِراسة		
7		مَدْفوع	ر ب ط	
8				
9	ن ج ر	نِجارة		
10				

Appendix 6

Questionnaires

Bilingual language exposure questionnaire (Arabic)

Survey Queue

University of Reading

استبيان التعرض اللغوي للطلاب

لقد تمت دعوتكم للمشاركة في هذا الاستبيان كون موافقتكم بمشاركة ابنكم/ابنتكم في دراستنا، والتي تتعلق بفحص مهارات القراءة ما بين الطلاب. سيقدم إلينا هذا الاستبيان معلومات قيمة حول التعرض اللغوي لابنكم/ابنتكم في الماضي. كما أن المشاركة في الاستبيان تطوعي ولن تكون هناك أي تداعيات بشأن عدم المشاركة. سيستغرق هذا الإستبيان حوالي 5-10 دقائق

سيتم إجراء الاستبيان من خلال منصة آمنة وسيتم الاحتفاظ بأي بيانات يتم جمعها بشكل آمن وسري على أن تستخدم في أغراض البحث فقط. وسيتم تخصيص رقم مميز بدل من اسم المشارك/ة أثناء إجراء هذه الدراسة للحفاظ على سرية المشارك/ة. وسيتم طرح نتائج الدراسة بطريقة لا تظهر هوية المشاركين

ستقدم نتائج هذا المشروع معلومات قيمة بشأن مهارات القراءة الخاصة بالطلاب ذوي المهارات المختلفة سواء كانت مهاراتهم تتميز بنقاط ضعف أو نقاط قوة. سيتم عرض نتائج هذا المشروع في تقرير جامعي ويمكن أن يتم عرض هذه النتائج في المؤتمرات الوطنية و الدولية. كما يمكن أن تنشر في المقالات المكتوبة

تمت مراجعة هذا المشروع وفقًا للإجراءات المتبعة من جانب (لجنة أخلاقيات البحث في جامعة ريدنج) وبالفعل فقد حصلت على موافقة مؤيدة للأخلاقيات البحثية السليمة. كما أن الجامعة توفر تأمينا مناسبا لهذا الأمر ويمكن الإطلاع على هذا التأمين بالتفصيل بناء على الطلب

حينما تكمل الاستبيان، فإنك بذلك توافق على مشاركتك في هذه الدراسة البحثية

يضم فريق عمل المشروع: الباحثة / لجين المتروك وكلا من المشرفين: د. هولي جوزيف و د. ديزي باول من قسم التربية في جامعة ريدنج

إذا كنت ترغب في المزيد من المعلومات ، فيرجى التواصل بـالأستاذة/ لجين المتروك عبر البريد الإلكتروني

l.y.almatrouk@pgr.reading.ac.uk

إذا كانت لديك أي استفسارات بخصوص حماية بياناتك الشخصية ، فيرجى التواصل مع البريد الإلكتروني التالي

imps@reading.ac.uk

الرجاء ملء الاستبيان التالي

و شكراً

الحضانة

سوف أطرح عليك الآن بعض الأسئلة حول التعرض اللغوي لابنكم/ابنتكم في الماضي. الرجاء الإجابة بأفضل ما لديك من معلومات

هل تلقى ابنكم/ابنتكم أي نوع من أنواع الرعاية في الحضانة تحديداً قبل سن 4 أعوام؟

* must provide value

- (●) نعم
- ( ) لا

reset

preschool attendance

منذ أي عمر بدأ ابنكم/ابنتكم في الذهاب إلى الحضانة؟

- ( ) في سن 0-1
- ( ) في سن 1-2
- ( ) في سن 2-3

reset

Preschool starting age

كم يوما في الأسبوع كان يذهب ابنكم/ابنتكم إلى الحضانة؟

- ( ) 1
- ( ) 2
- ( ) 3
- ( ) 4
- ( ) 5

reset

Frequency of attendance at preschool

بشكل عام، أي (لغة/لغات) كانت تستخدم أثناء وجوده في الحضانة؟

- ( ) اللغة العربية
- ( ) اللغة الانجليزية
- ( ) كلاهما
- ( ) لم تستخدم أيا منهما

reset

Language(s) used in preschool

بشكل عام، ما هو معدل إستخدام الحضانة للغة الانجليزية؟

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

- ( ) 0%
- ( ) 25%
- ( ) 50%
- ( ) 75%
- ( ) 100%

reset

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المدرسة

والآن ، تذكر الحالة التعليمية لدى الطفل بدءًا من مرحلة الروضة وحتى الصف الثالث

بشكل عام، ما هو معدل التحدث باللغة الإنجليزية في المدرسة؟

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

	0%	25%	50%	75%	100%	
من سن 4 الي 5 (الروضة سنة أولى)	○	○	○	○	○	reset
من سن 5 إلى 6 (الروضة سنة ثانية)	○	○	○	○	○	reset
من سن 6 إلى 7 (الصف الاول) *	○	○	○	○	○	reset
من سن 7 إلى 8 (الصف الثاني) *	○	○	○	○	○	reset
من سن 8 إلى 9 (الصف الثالث) *	○	○	○	○	○	reset

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ممارسة الأنشطة بعد ساعات الدوام المدرسي

تذكر الأنشطة التي كان يقوم بها ابنكم/ابنتكم بعد انتهاء ساعات الدوام المدرسي سواء داخل أو خارج المدرسة من أيام الروضة لغاية الصف الثالث

هل كان ابنكم/ابنتكم يواظب على حضور الأنشطة بعد ساعات الدوام المدرسي؟

* must provide value

- ◉ نعم
- ○ لا

reset

Activities after school

كم كانت عدد الساعات التي يقضيها الطفل في ممارسة تلك الأنشطة أسبوعياً؟

After school activity attendance frequency

بشكل عام، أي (لغة/لغات) كانت تستخدم خلال تلك الأنشطة؟

- ○ اللغة العربية
- ○ اللغة الانجليزية
- ○ كلاهما
- ○ لم تستخدم أيا منهما

reset

Language(s) used in after school activity

بشكل عام، ما هو معدل إستخدام اللغة الانجليزية في تلك الأنشطة؟

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

- ○ 0%
- ○ 25%
- ○ 50%
- ○ 75%
- ○ 100%

reset

LE at after school activity

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المنزل

الآن ، تذكر معدل استخدامك للغة مع طفلك في الماضي منذ ولادته وحتى عمر 9 أعوام

بشكل عام، ما هو معدل التحدث باللغة الإنجليزية مع ابنك/ابنتك في المنزل؟

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

	0%	25%	50%	75%	100%	
منذ الولادة وحتي عمر 3 أعوام *						reset
منذ عمر 3 إلي 6 أعوام *						reset
منذ عمر 6 إلي 9 أعوام *						reset

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ما هو معدل تحدث الوالد الآخر مع ابنك/ابنتك باللغة الإنجليزية في المنزل؟ إن لم يكن للطفل والدين، فيرجي اجتياز هذا السؤال

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

	0%	25%	50%	75%	100%	
منذ الولادة وحتي عمر 3 أعوام						reset
منذ عمر 3 إلي 6 أعوام						reset
منذ عمر 6 إلي 9 أعوام						reset

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ما هو معدل تحدث الأخوة مع ابنك/ابنتك باللغة الإنجليزية في المنزل؟ إن لم يكن للطفل أية إخوه فيرجي اجتياز هذا السؤال

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

	0%	25%	50%	75%	100%	
منذ الولادة وحتي عمر 3 أعوام						reset
منذ عمر 3 إلي 6 أعوام						reset
منذ عمر 6 إلي 9 أعوام						reset

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هل كان يوجد أشخاص بالغين يسكنون مع الطفل في نفس المنزل؟ إن كانت الإجابة نعم، فما هي وجه القرابة؟ إن كانت الإجابة لا، فيرجي اجتياز هذا السؤال

- ☐ الجدة
- ☐ الجد
- ☐ العم/الخال
- ☐ العمة/الخالة
- ☐ زوج الأم
- ☐ زوجة الأب
- ☐ المربية
- ☐ غير ذلك

ما هو معدل استخدام الأشخاص البالغين الذين يسكنون مع الطفل في نفس المنزل للغة الإنجليزية؟
(إن لم يكن هناك أي من الأشخاص البالغين يسكنون مع الطفل في نفس المنزل فيرجي اجتياز هذا السؤال)

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

	0%	25%	50%	75%	100%	
الجدة	○	○	○	○	○	reset
الجد	○	○	○	○	○	reset
العم/الخال	○	○	○	○	○	reset
العمة/الخالة	○	○	○	○	○	reset
زوج الأم	○	○	○	○	○	reset
زوجة الأب	○	○	○	○	○	reset
المربية	○	○	○	○	○	reset
غير ذلك	○	○	○	○	○	reset

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الإجازات

والآن، تذكر استخدام طفلك للغة تحديداً أثناء الإجازات منذ الولادة وحتى عمر 9 أعوام

بشكل عام، ما هو معدل التعرض للغة الانجليزية خلال الاجازة؟

بالكاد تستخدم الإنجليزية، حيث كان دائماً استخدام العربية = 0%
نادراً ما تستخدم الإنجليزية و غالباً ما تستخدم العربية = 25%
تستخدم الإنجليزية بمعدل 50% و العربية بمعدل 50% = 50%
غالباً ما تستخدم الإنجليزية و نادراً ما تستخدم العربية = 75%
غالباً ما تستخدم الإنجليزية وبالكاد أن تستخدم العربية = 100%

* must provide value

- ○ 0%
- ○ 25%
- ○ 50%
- ○ 75%
- ○ 100%

reset

LE holidays

هل هناك أي معلومات هامة خاصة باستخدام طفلك للغات في الماضي وتعتقد أنه لم يتم تغطيتها بعد؟

المعلومات العامة

يرجي ذكر الإسم الاول و الإسم الأخير لطفلك

* must provide value

يرجي ذكر علاقتك بالطفل

على سبيل المثال: الأم، الأب ، الجد، الجدة

* must provide value

Survey completed by

يرجي ذكر عدد الأطفال بالعائلة

Number of children

يرجي ذكر اللهجة العربية المستخدمة في الحديث بالمنزل

على سبيل المثال: اللهجة الكويتية، اللهجة المصرية، اللهجة اللبنانية

* must provide value

dialect

يرجي اختيار المستوى التعليمي لوالدة الطفل

التعليم الأساسي (الابتدائي و المتوسط) =1
التعليم الثانوي (مرحلة الثانوية) =2
التعليم العالي (البكالوريوس) =3
الدراسات العليا (الماجستير والدكتوراة) =4

* must provide value

- 1
- 2
- 3
- 4

reset

Education level mother

يرجي اختيار المستوى التعليمي لوالد الطفل

التعليم الأساسي (الابتدائي و المتوسط) =1
التعليم الثانوي (مرحلة الثانوية) =2
التعليم العالي (البكالوريوس) =3
الدراسات العليا (الماجستير والدكتوراة) =4

* must provide value

- 1
- 2
- 3
- 4

reset

Education level father

يرجي ذكر وظيفة والدة الطفل

* must provide value

Mother occupation

يرجي ذكر وظيفة والد الطفل

* must provide value

Father occupation

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Submit

Bilingual language exposure questionnaire (English)

Bilingual Language Exposure Questionnaire

You have been invited to take part because you have given consent for your child to be part of our study, which is related to examining reading skills among children. This survey will provide us with information about your child's language exposure in the past. It is entirely up to you whether you take part and there will be no repercussions if you choose not to. The survey will take approximately 5-10 minutes to complete.

The survey will be conducted via a secure survey platform and any data collected will be held securely and in strict confidence for the purposes of the research survey only. Participants will be assigned a unique number whilst the study is undertaken. The results of the study will not be presented in a way that will identify you.

Findings from this project will provide important knowledge about reading skills among readers with different profiles of strengths and weaknesses. The results of the study will be written up as a report for the University and may also be presented at national and international conferences and published in written articles.

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.

By completing this survey, you are consenting to your participation in this research study.

The project team includes the researcher Lujain AlMatrouk and her supervisors Dr Holly Joseph and Dr Daisy Powell, Institute of Education, University of Reading.

If you would like more information, please contact Lujain AlMatrouk Email: l.y.almatrouk@pgr.reading.ac.uk.
If you have any queries regarding protection of your personal data, please contact imps@reading.ac.uk.

Please complete the survey below.

Thank you!

Preschool I am now going to ask you some questions about your child's language exposure in the past. Please answer to the best of your ability.

Did your child have any kind of preschool care before the age of 4?
(preschool attendance)

○ Yes
○ No

At what age did your child start attending preschool?
(Preschool starting age)

○ 0-1 year old
○ 1-2 years old
○ 2-3 years old

For about how many days per week did your child attend preschool?
(Frequency of attendance at preschool)

○ 1
○ 2
○ 3
○ 4
○ 5

In general, which language(s) were used at the preschool?
(Language(s) used in preschool)

○ Arabic
○ English
○ Both
○ Neither

In general, how much English was spoken at the preschool?

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic
(LE at preschool)

○ 0%
○ 25%
○ 50%
○ 75%
○ 100%

School Now, think about your child's schooling starting from Kindergarten up until the 3rd grade.

In general, please indicate below how much English was spoken at school?

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic

	0%	25%	50%	75%	100%
Age 4 to 5 (KG1)	○	○	○	○	○
Age 5 to 6 (KG2)	○	○	○	○	○
Age 6 to 7 (Grade 1)	○	○	○	○	○
Age 7 to 8 (Grade 2)	○	○	○	○	○
Age 8 to 9 (Grade 3)	○	○	○	○	○

After school hours After school hours were over, think about the activities your child spent doing whether at the school or outside the school up until the 3rd grade.

Did your child ever regularly attend any activities after school hours were over?
(Activities after school)

◯ Yes
◯ No

For about how many hours per week did your child attend this regular after school hours activity?
(After school activity attendance frequency)

◯ 1
◯ 2
◯ 3
◯ 4
◯ 5
◯ 6
◯ 7
◯ 8
◯ 9
◯ 10
◯ more than 10

In general, which language(s) were used at the after-school activity?
(Language(s) used in after school activity)

◯ Arabic
◯ English
◯ Both
◯ Neither

In general, how much English was spoken at the after-school activity?

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic
(LE at after school activity)

◯ 0%
◯ 25%
◯ 50%
◯ 75%
◯ 100%

Home Now, think about your own language use with your child in the past from birth until Age 9.

At home, how often did you speak English to the child?

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic

	0%	25%	50%	75%	100%
Birth to age 3	○	○	○	○	○
Age 3 to 6	○	○	○	○	○
Age 6 to 9	○	○	○	○	○

At home, how often did the second parent speak English to the child? (if the child had one parent only, please skip this question)

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic

	0%	25%	50%	75%	100%
Birth to age 3	○	○	○	○	○
Age 3 to 6	○	○	○	○	○
Age 6 to 9	○	○	○	○	○

At home, how often did the siblings (if any) speak English to the child? If the child didn't have any siblings, please skip this question.

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic

	0%	25%	50%	75%	100%
Birth to age 3	○	○	○	○	○
Age 3 to 6	○	○	○	○	○
Age 6 to 9	○	○	○	○	○

Have any other adults lived at home? What is their relationship to your child? (If no other adults lived at home, please skip this question).

_____

How often did the adult living at home speak English to your child? (If no other adults lived at home, please skip this question).

0% = hardly ever English, almost always Arabic
25% = Seldom English, usually Arabic
50% English, 50% Arabic
75% = Usually English, seldom Arabic
100% = almost always English, hardly ever Arabic

	0%	25%	50%	75%	100%
Grandmother	○	○	○	○	○
Grandfather	○	○	○	○	○
Uncle	○	○	○	○	○
Aunt	○	○	○	○	○
Step-parent	○	○	○	○	○
Nanny	○	○	○	○	○
Other	○	○	○	○	○

Holidays Now, think about your child's language exposure in the past during the holidays, from birth up until Age 9.

During the holidays, in general, how much contact did your child have with English?

0% = hardly ever English, almost always Arabic
25% = seldom English, usually Arabic
50% = 50% English, 50% Arabic
75% = usually English, seldom Arabic
100% = almost always English, hardly ever Arabic
(LE holidays)

◯ 0%
◯ 25%
◯ 50%
◯ 75%
◯ 100%

Is there any other important information about your child's language use in the past that you think we've not covered?
(additional info)

General Information

Please enter your child's first and last name.

____

Please enter your relationship to the child.

(For example: mother, father, grandparent, etc.)

____
(Survey completed by)

Please enter the total number of children in the family.

____
(Number of children)

Please enter the Arabic dialect spoken at home.

(For example: Kuwaiti, Egyptian, Lebanese, etc.)

____
(dialect)

Please select the educational level for the child's mother.

1= primary education (Elementary/Middle School)
2= secondary education (High school)
3= higher education (Bachelor's)
4= postgraduate education (Master's/PhD)
(Education level mother)

◯ 1
◯ 2
◯ 3
◯ 4

Please select the educational level for the child's father.

1= primary education (Elementary/Middle School)
2= secondary education (High school)
3= higher education (Bachelor's)
4= postgraduate education (Master's/PhD)
(Education level father)

◯ 1
◯ 2
◯ 3
◯ 4

Please enter the occupation for the child's mother.

____
(Mother occupation)

Please enter the occupation for the child's father.

____
(Father occupation)

Appendix 7

The revised standardized difference test (RSDT), which tests whether the standardized differences between tasks X and Y is statistically different from the distribution of differences in the control sample

$$\psi = \frac{\left[\frac{X^{*} - \overline{X}}{S_x}\right] - \left[\frac{Y^{*} - \overline{y}}{S_y}\right]}{(n+1)/n[\sqrt{2 - 2\mathrm{r} + \frac{2(1-\mathrm{r}^2)}{\mathrm{n}-1} + \frac{(5+\mathrm{y}^2)(1-\mathrm{r}^2)}{2(\mathrm{n}-1)^2}} + r(1+y^2)(1-r^2)/2(n-1)^2}$$

X* is the case's score on task X

$\overline{X}$ and S_x are the mean and standard deviation of the control sample's scores on task X

Y* is the case's score on task Y

$\overline{y}$ and S_y are the mean and standard deviation of the control sample' scores on task Y

n is the size of the control sample

r is the correlation between task X and Y in the control sample

y is the critical 2-tail value for *t* on *n*-1 *df*

If ψ is greater than the two-tailed value for *t* on n -1 *df*, then the case's score is significantly different from control sample scores (Crawford & Garthwaite, 2005b).

Appendix 8

Data screening measures

Study 1: comparison between typically developing children and children with RD attending bilingual schools

Data screening measures for control variables; the values in the table are for the typically developing group (TD) and the values between brackets are for the reading difficulties group (RD)

Measure	Skewness *Z*	Kurtosis *Z*	*D*	*F(1,51)*	*Histogram*	*Normality*
Nonverbal Ability	-0.75 (-1.6)	-1.5 (-0.08)	0.92* (0.92)	0.09	Bell (skewed)	Normal (normal)
Receptive Vocabulary (English)	-0.2 (0.2)	-0.5 (-0.6)	0.96 (0.95)	1.42	Bell (skewed)	Normal (normal)
Receptive Vocabulary (Arabic)	2.0* (2.0*)	0.4 (0.7)	0.92* (0.91)	5.51*	Skewed	Not normal (normal)
Socioeconomic Status	0.5 (-1.0)	0.4 (0.3)	0.89** (0.86**)	0.11	Bell (bell)	Normal (normal)
CLE to English	-0.2 (0.1)	-0.6 (-0.8)	0.98 (0.98)	1.63	Bell (bell)	Normal (normal)

$^{*}p < .05$. $^{**}p < .01$. ***p < .001. *Note:* D indicates the value for the Shapiro-Wilk test. The degrees of freedom for the Shapiro-Wilk test for the TD group = 34, RD group = 19. The F test indicates Levene's test to assess for homogeneity of variance.

Data screening measures for English variables; the values in the table are for the typically developing group (TD) and the values between brackets are for the reading difficulties group (RD)

Measure	Skewness *Z*	Kurtosis	*D*	*F(1,51)*	*Histogram shape*	*Normality*
Reading accuracy	-1.75 (-0.2)	-0.5 (-0.7)	0.93* (0.98)	9.23**	Skewed (bell)	Normal (normal)
Reading fluency	-1.25 (0.4)	-0.3 (-0.5)	0.96 (0.96)	2.52	Skewed (bell)	Normal (normal)
Morphological awareness	-3.1** (-1.3)	3.3** (-0.4)	0.91** (0.93)	4.30*	Skewed (bell)	Not normal (normal)
Phonological awareness	-4.5*** (0.06)	4.75*** (-1.2)	0.80*** (0.94)	30.30***	Skewed (bell)	Not normal (normal)
Rapid Automatized Naming	1.75 (4.0***)	0.75 (3.6***)	0.96 (0.74***)	7.20*	Skewed (bimodal)	Normal (not normal)
Phonological Memory	-1.0 (-0.4)	1.5 (0.5)	0.95 (0.95)	1.44	Skewed (bell)	Normal (normal)

$^{*}p < .05$. $^{**}p < .01$. ***p < .001. Reading accuracy, fluency, and morphological awareness are composite variables while phonological awareness, RAN, and phonological memory are raw scores. D indicates the value for the Shapiro-Wilk test. The degrees of freedom for the Shapiro-Wilk test for the TD group = 34, RD group = 19. The F test indicates Levene's test to assess for homogeneity of variance.

Data screening measures for Arabic variables; the values in the table are for the typically developing group (TD) and the values between brackets are for the reading difficulties group (RD)

Measure	Skewness *Z*	Kurtosis *Z*	*D*	*F(1,51)*	*Histogram shape*	*Normality*
Reading accuracy	-3.0** (1.0)	1.0 (-1.0)	0.87*** (0.90*)	8.82**	skewed (bimodal)	Not normal
Reading fluency	0.5 (2.4*)	-0.06 (0.1)	0.98 (0.78***)	7.10*	bell (skewed)	Normal (not normal)
Morphological awareness	-2.25* (-0.5)	-0.5 (-1.0)	0.87*** (0.94)	4.21*	skewed (skewed)	Not normal (normal)
Phonological awareness	-1.75 (-1.2)	0.9 (-0.2)	0.95 (0.94)	6.31*	bell (skewed)	Normal (normal)
Rapid Automatized Naming	1.5 (1.0)	-0.9 (-0.8)	0.93* (0.94)	3.05	bimodal (skewed)	Not normal (normal)
Phonological Memory	-1.0 (-0.1)	-1.0 (-1.0)	0.94** (0.94)	0.09	skewed (skewed)	Not normal (normal)

$^{*}p < .05$. $^{**}p < .01$. ***p < .001. Note: Reading accuracy, fluency, and morphological awareness are composite variables while phonological awareness, RAN, and phonological memory are raw scores. D indicates the value for the Shapiro-Wilk test. The degrees of freedom for the Shapiro-Wilk test for the TD group = 34, RD group = 19. The F test indicates Levene's test to assess for homogeneity of variance.

Study 2: comparison between typically children with RD attending bilingual schools and children with RD attending monolingual schools

Data screening measures for control variables; the values in the table are for the monolingual RD group (MRD) and the values between brackets are for bilingual RD group (BRD)

Measure	Skewness *Z*	Kurtosis *Z*	*D*	*F(1,38)*	*Histogram*	*Normality*
Nonverbal Ability	-0.12 (-1.6)	-1.3 (-0.08)	0.93 (0.92)	0.12	skewed	Normal (normal)
Receptive Vocabulary (Arabic)	-0.2 (2.2*)	-1.0 (0.7)	0.94 (0.91)	0.34	Bell (Skewed)	Normal (normal)
Socioeconomic Status	0.2 (-1.0)	-0.4 (0.3)	0.91 (0.86**)	2.15	Skewed	Normal (normal)
CLE to Arabic	-2.0* (-0.1)	0.04 (-0.8)	0.88* (0.98)	1.44	Skewed (bell)	Not normal (normal)

$^{*}p < .05$. $^{**}p < .01$. ***p < .001. Note: D indicates the value for the Shapiro-Wilk test. The degrees of freedom for the Shapiro-Wilk test for the TD group = 21, RD group = 19. The F test indicates Levene’s test to assess for homogeneity of variance.

Data screening measures for Arabic variables; the values in the table are for the monolingual RD group (MRD) and the values between brackets are for bilingual RD group (BRD)

Measure	Skewness *Z*	Kurtosis *Z*	*D*	*F(1,38)*	*Histogram shape*	*Normality*
Reading accuracy	-0.3 (1.0)	-0.8 (-1.3)	0.95 (0.91*)	0.09	Bell (skewed)	Normal (not normal)
Reading fluency	2.4* (2.4)*	1.2 (0.09)	0.89**(0.79***)	1.87	Skewed (skewed)	Not normal
Morphological awareness	-0.4 (-0.1)	0.4 (-1.0)	0.98 (0.94)	1.23	bell (bell)	Normal (normal)
Phonological awareness	0.2 (-1.2)	-0.4 (-0.2)	0.97 (0.94)	0.30	bell (bell)	Normal (normal)
Rapid Automatized Naming	0.4 (1.0)	-0.7 (-0.8)	0.96 (0.95)	2.22	Skewed (skewed)	Not normal (normal)
Phonological Memory	0.8 (-0.1)	-1.0 (-1.0)	0.91 (0.94)	0.02	Skewed (skewed)	Not normal

$^{*}p < .05$. $^{**}p < .01$. ***p < .001. Note: Reading accuracy, fluency, and morphological awareness are composite variables while phonological awareness, RAN, and phonological memory are not. D indicates the value for the Shapiro-Wilk test. The degrees of freedom for the Shapiro-Wilk test for the TD group = 21, RD group = 19. The F test indicates Levene's test to assess for homogeneity of variance.

Appendix 9

Calculating a 95% confidence interval for the effect size (Z_{dcc}) using Bayesian methods

$$Z_{dcci} = \frac{\left[\frac{X^* - \overline{\mu_x}}{S_x}\right] - \left[\frac{Y^* - \overline{\mu_y}}{S_y}\right]}{\sqrt{2 - 2\rho_{xy}}}$$

Estimates for μ and ∑ are generated by random by using an inverse Wishart distribution. X* and Y* scores are converted to z scores using the estimated means and standard deviations divided by the estimate standard deviation of their difference. $\boldsymbol{\rho}_{xy}$ is the is the estimated correlation between the two tasks calculated from the estimated variance and covariances. This was repeated one million times to calculate the 95% confidence interval for the effect size using Bayesian methods using the 25,000th smallest and largest effect size as the upper and lower limit of the interval (Crawford et al., 2010).

μ = the vector of population means

∑ = the variance-covariance matrix of the control population

Appendix 10

Figures summarizing z scores for phonological and morphological tasks for each reading difficulties case using single case analysis

Figure 1. *Case 2 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

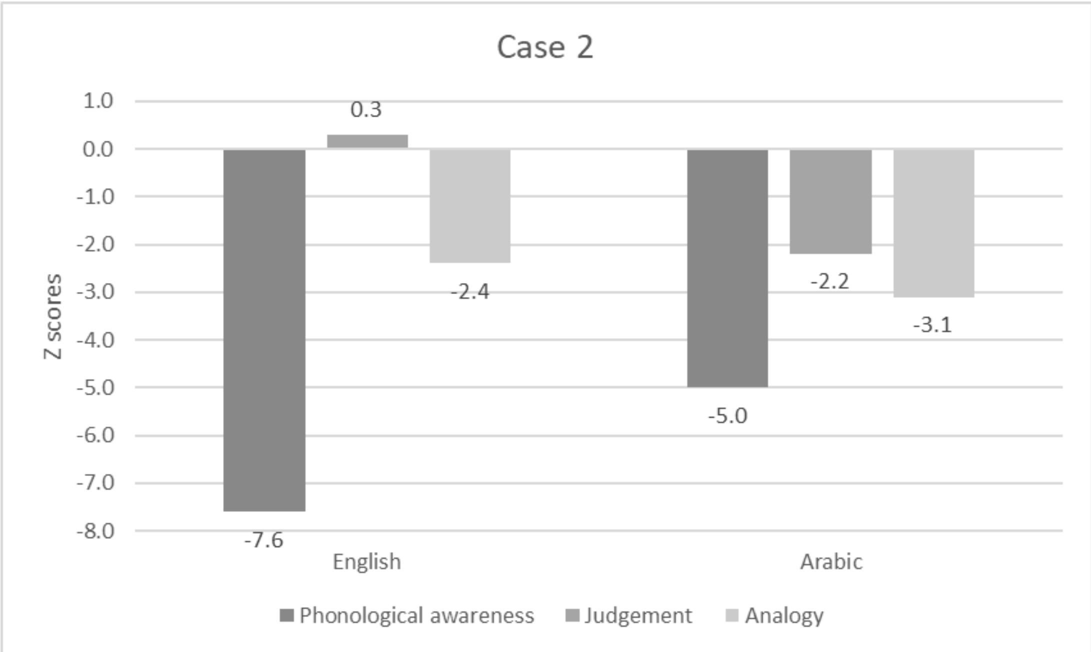


Figure 2. *Case 3 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

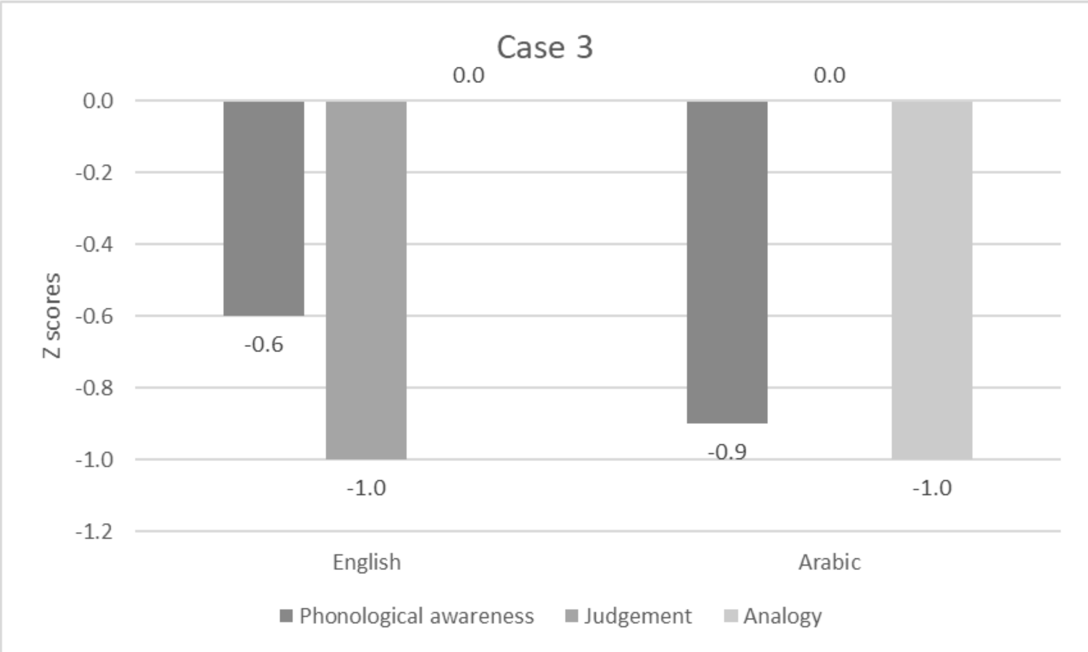


Figure 3. *Case 4 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

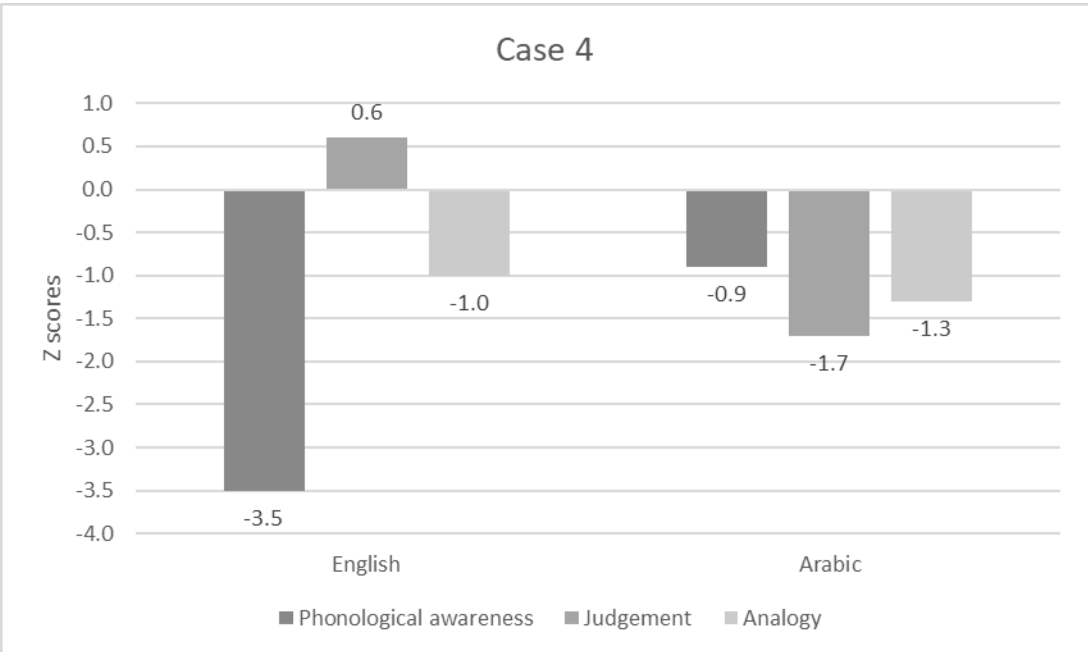


Figure 4. *Case 5 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

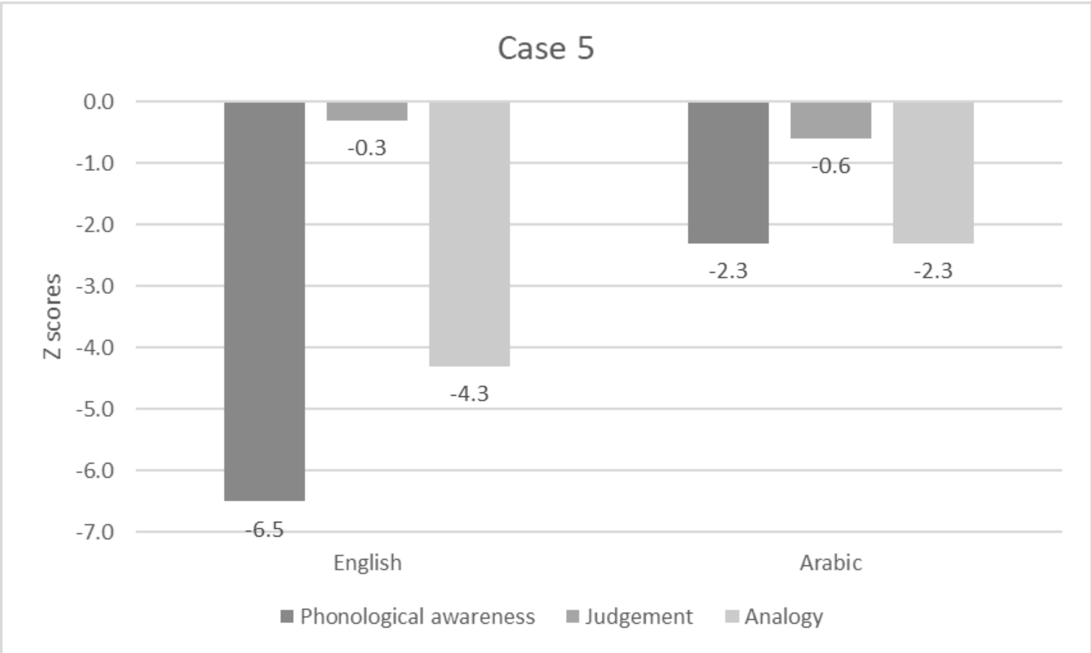


Figure 5. *Case 6 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

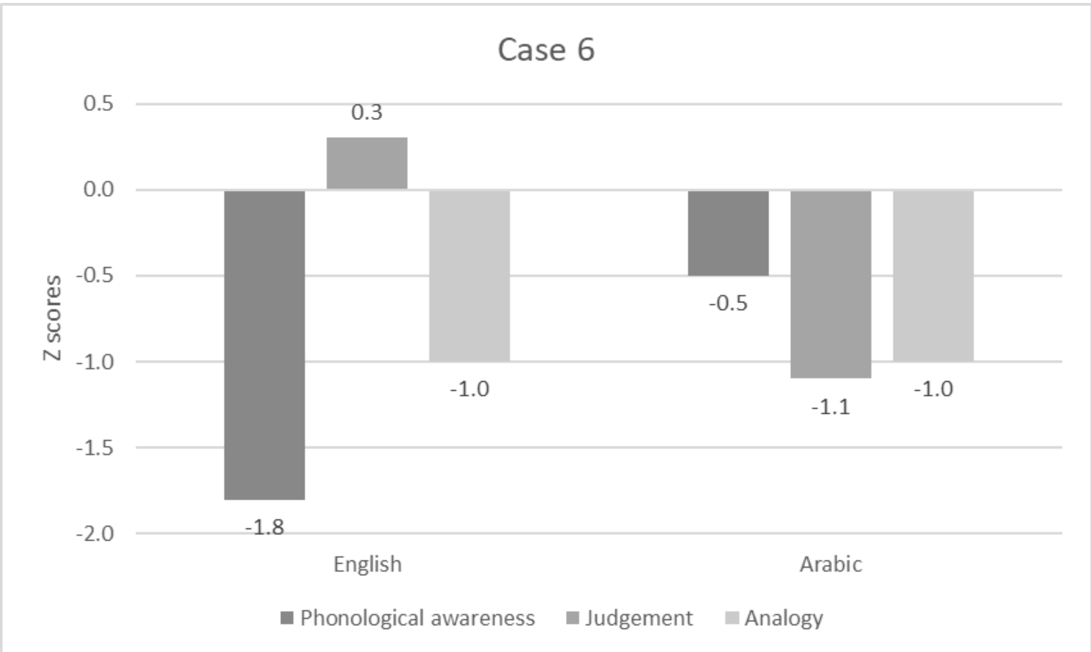


Figure 6. *Case 7 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

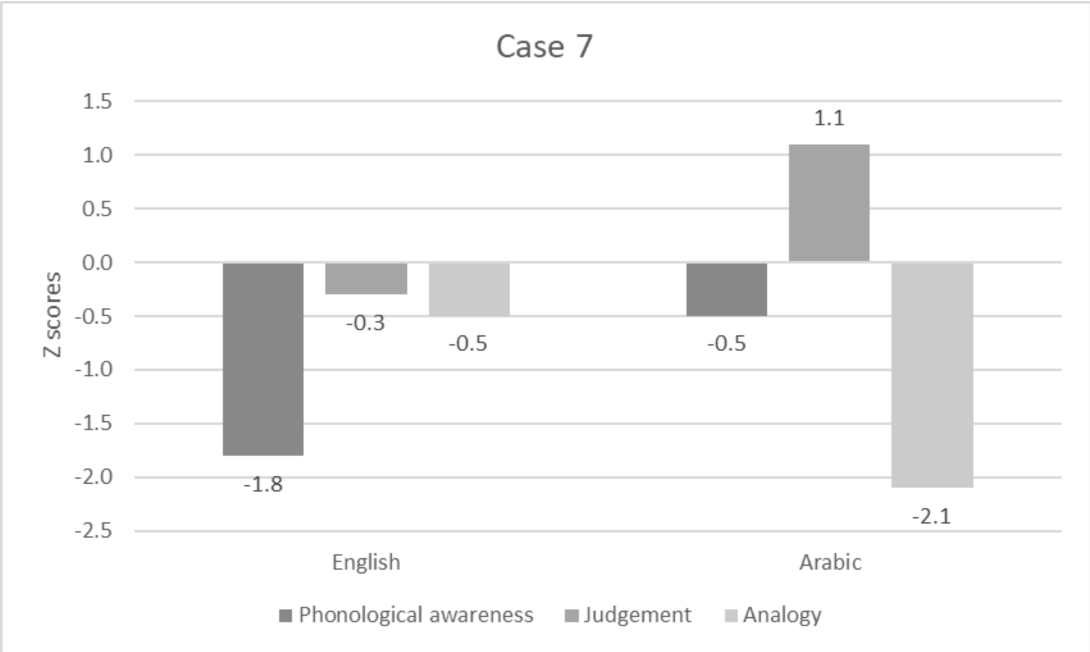


Figure 7. *Case 8 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

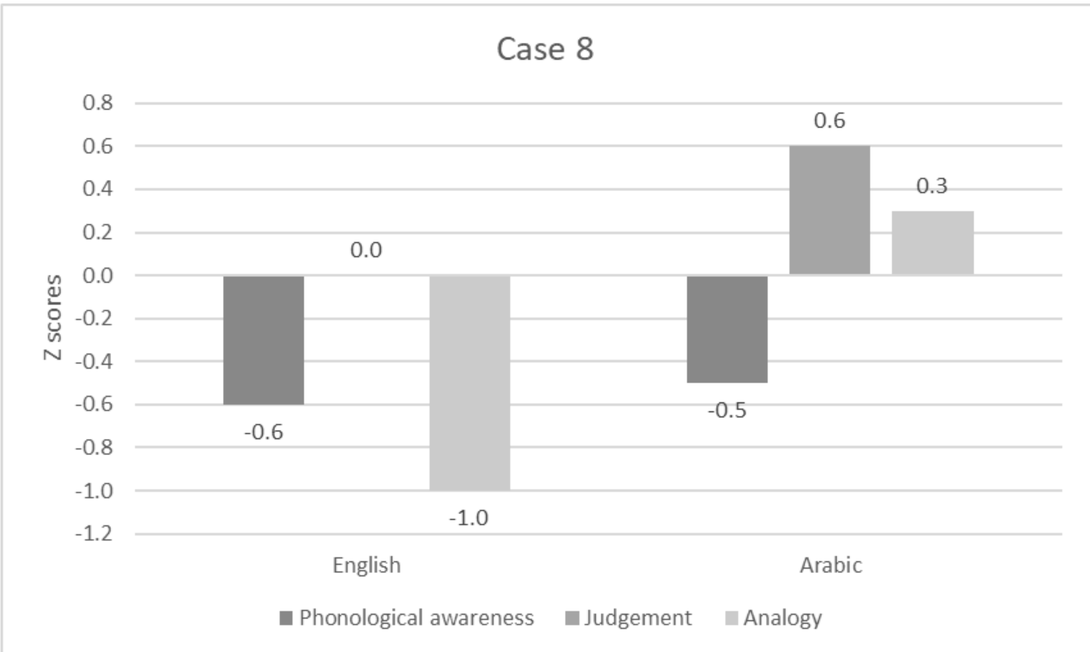


Figure 8. *Case 9 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

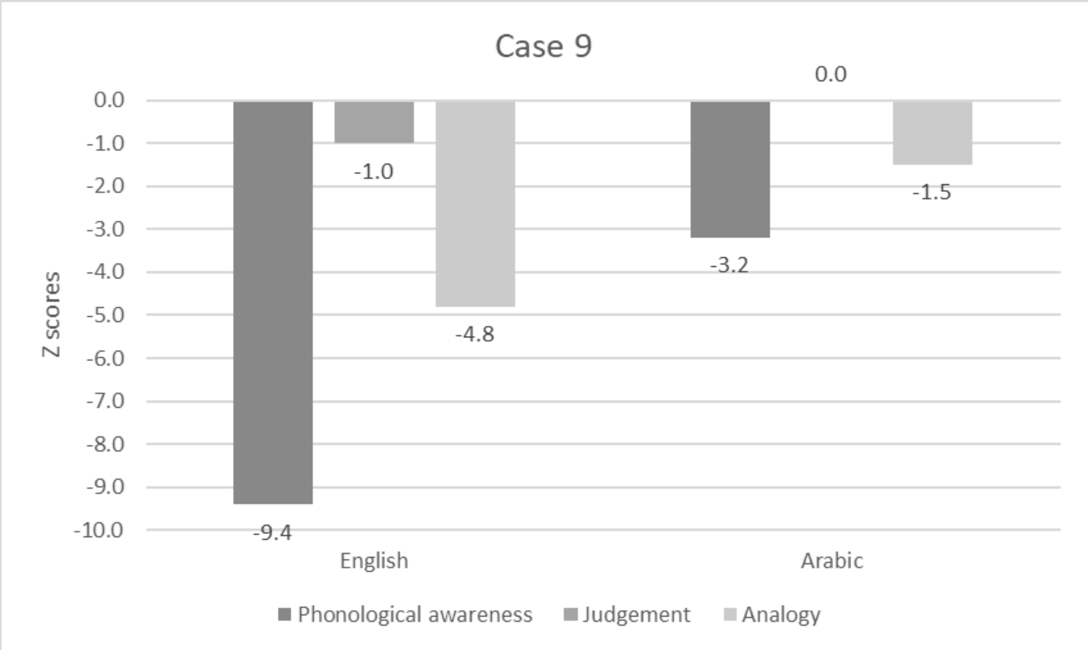


Figure 9. *Case 10 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

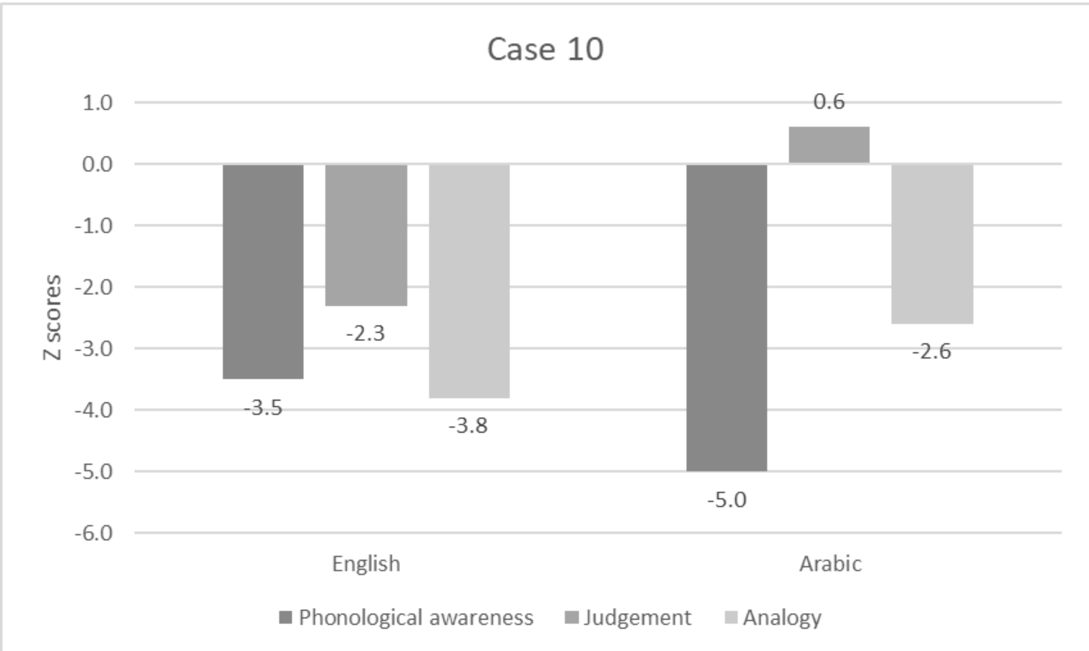


Figure 10. *Case 11 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

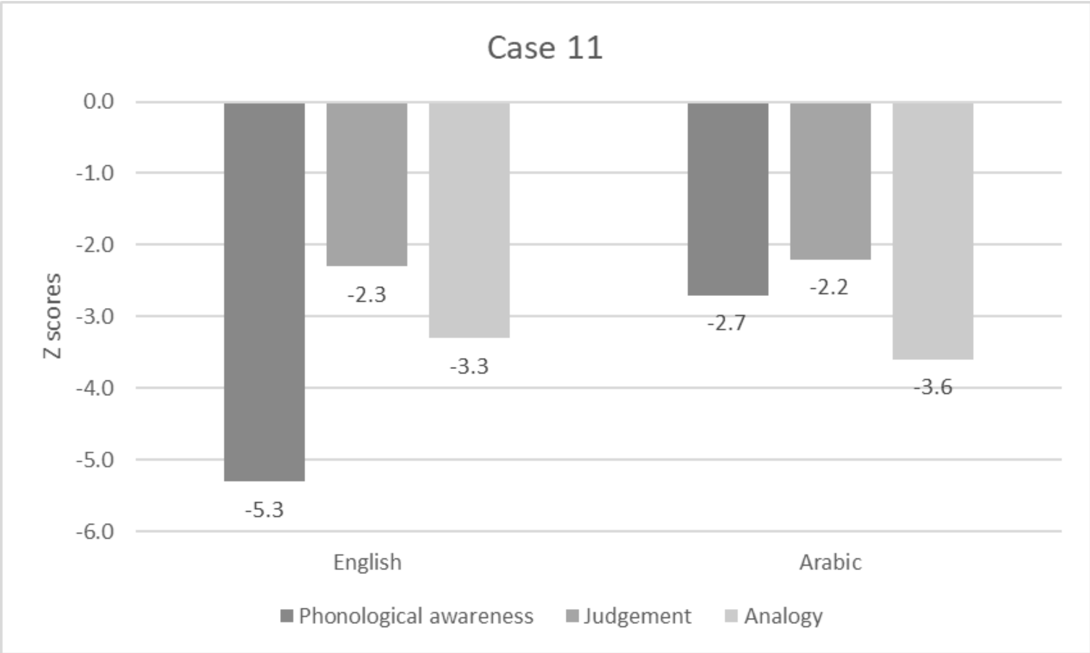


Figure 11. *Case 12 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

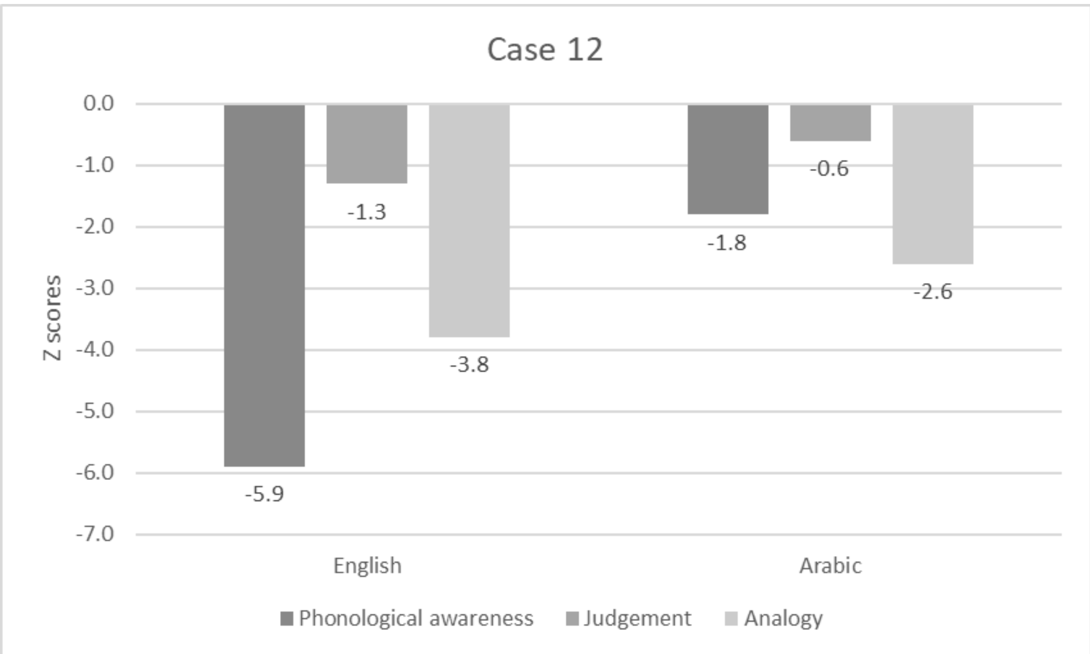


Figure 12. *Case 13 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

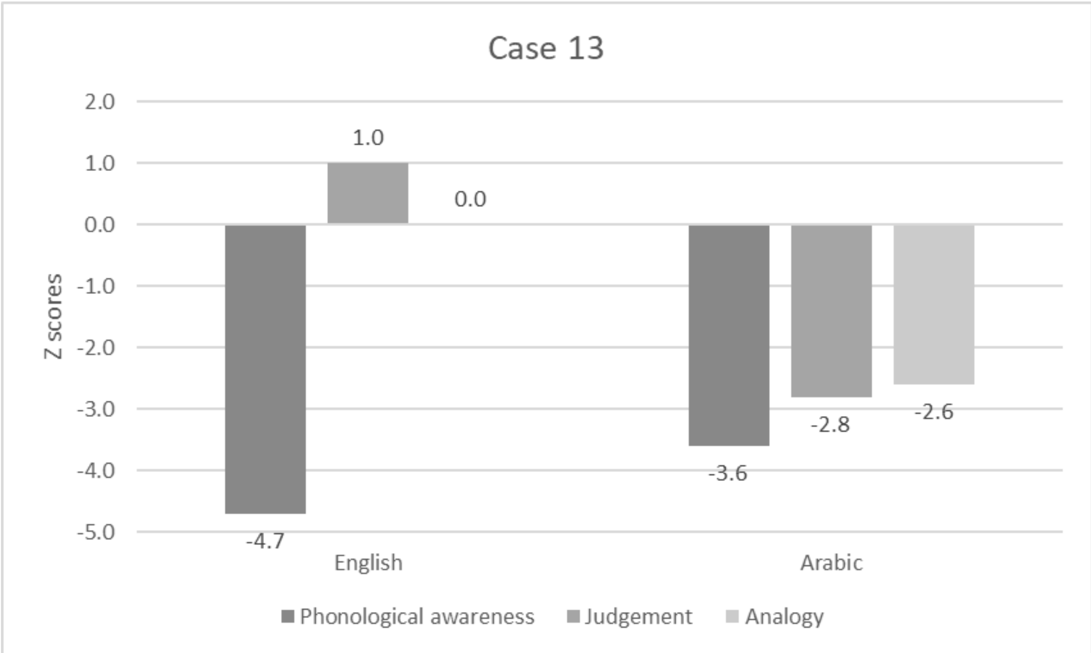


Figure 13. *Case 14 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

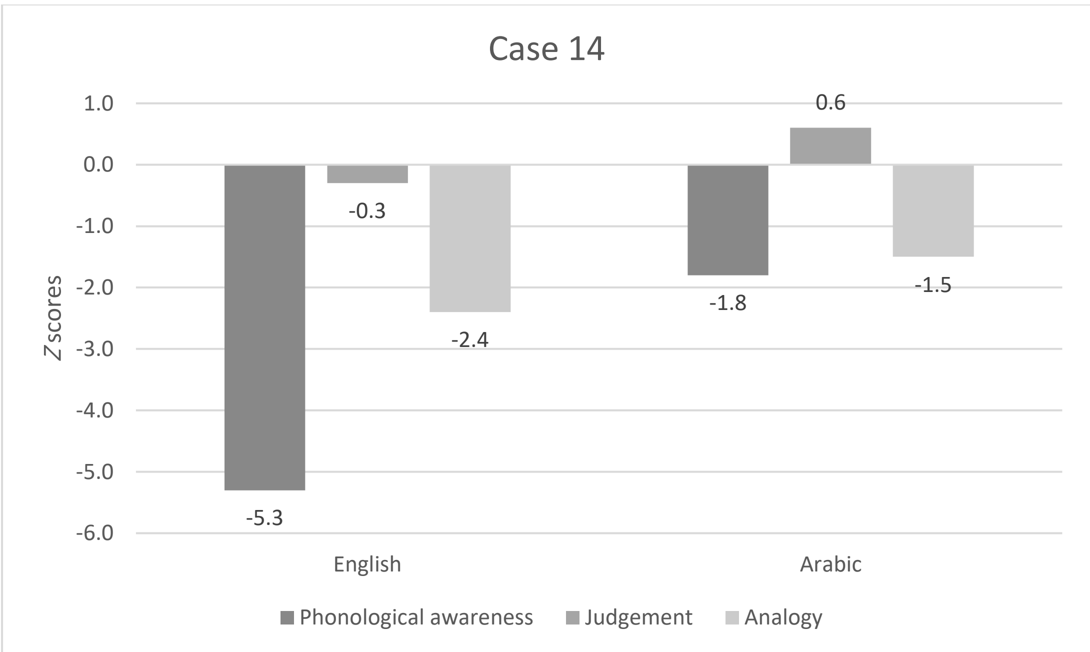


Figure 14. *Case 15 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

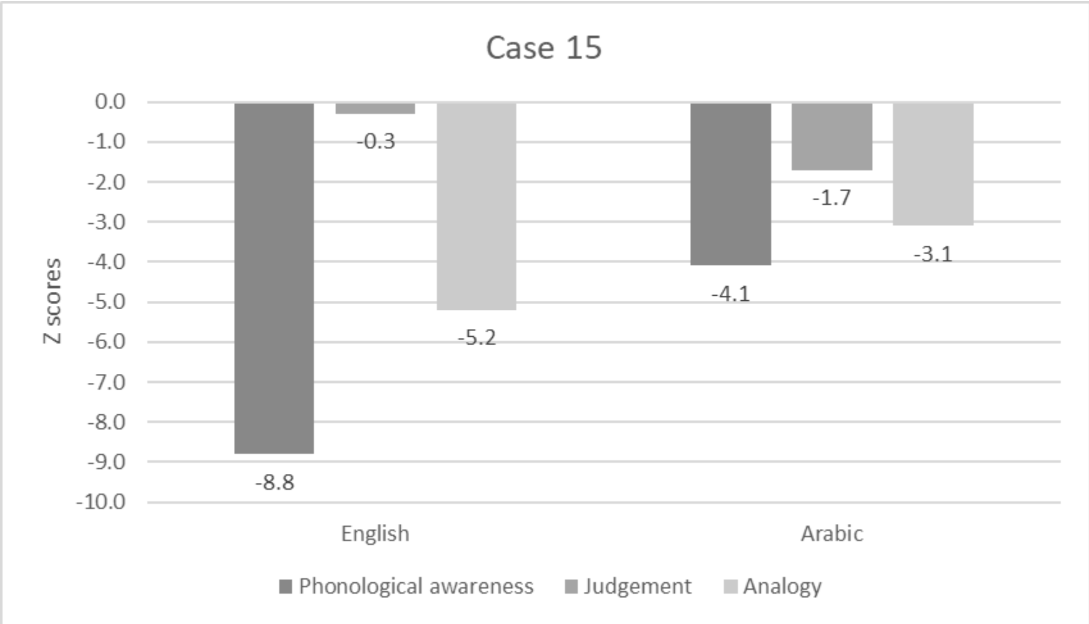


Figure 15. *Case 16 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

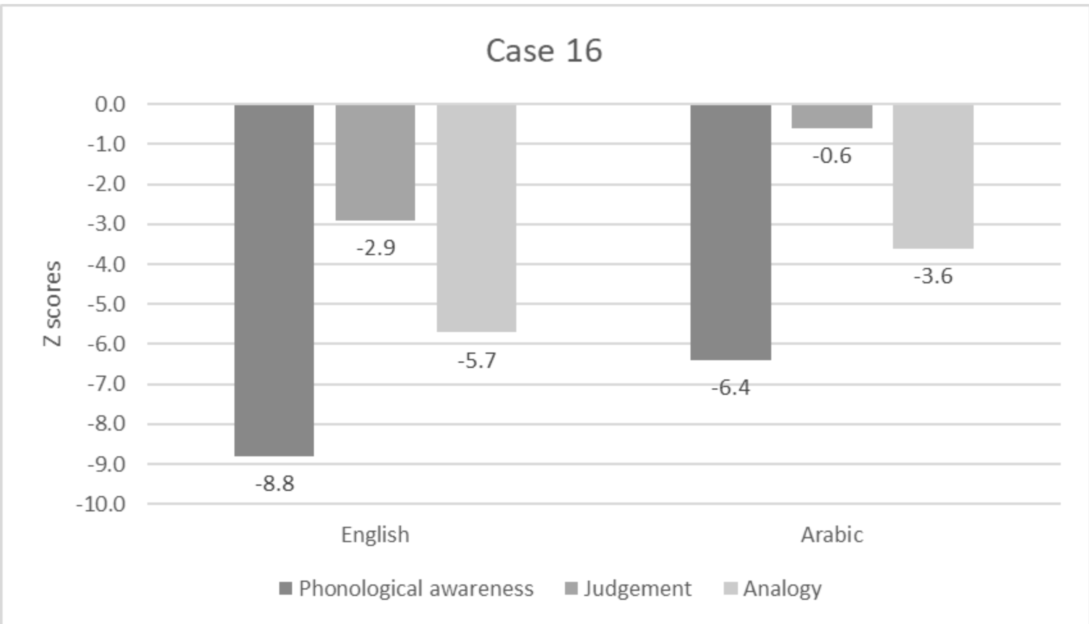


Figure 16. *Case 17 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

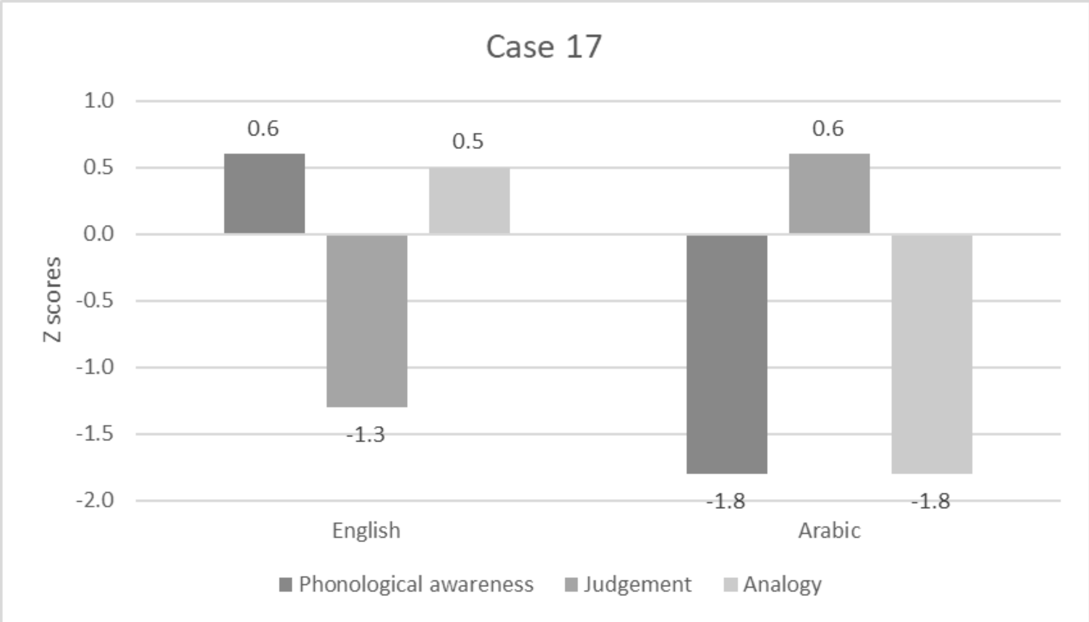


Figure 17. *Case 18 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*

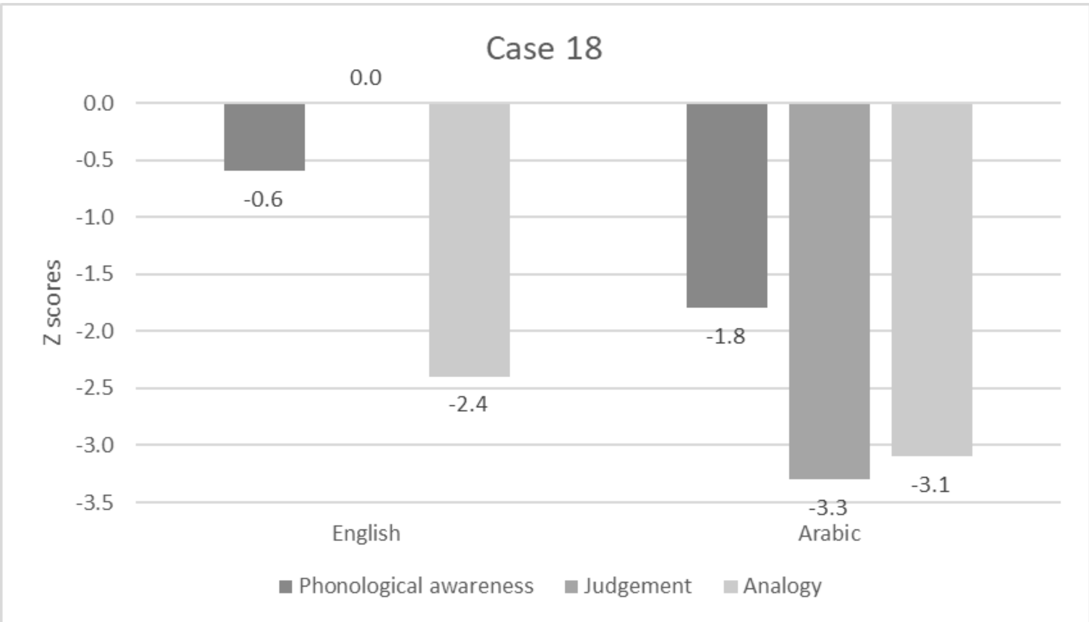
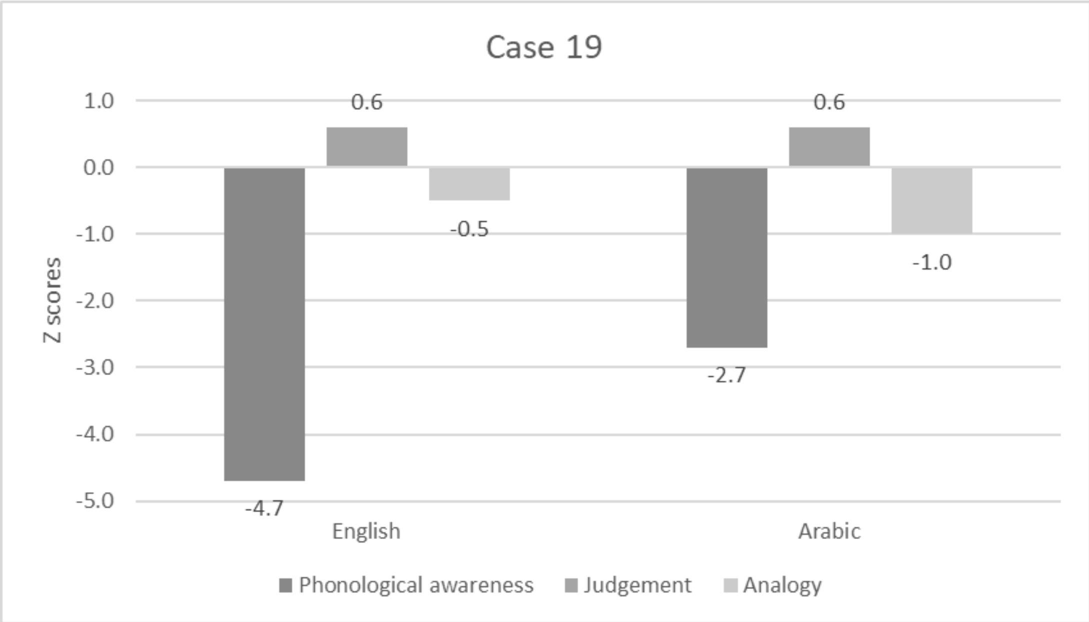


Figure 18. *Case 19 z-scores on phonological awareness and morphological knowledge tasks in English and Arabic*



Appendix 11

Table summarizing descriptive statistics on all Arabic tasks in Study 2

Table 1. Summary of descriptive statistics on all Arabic tasks (N = 40)

Measure	MRD Group (n = 21)		BRD Group (n = 19)	
	M	*SD*	*M*	*SD*
Nonword Reading Accuracy[1]	9.24	9.52	6.79	7.26
Unvoweled Word Reading[1]	15.86	7.83	10.74	8.77
Voweled Word Reading[1]	16.33	7.79	9.05	8.07
Reading Accuracy Composite	0.27	0.85	-0.30	0.85
Real word reading fluency[2]	11.14	8.82	9.79	4.95
Nonword reading fluency[3]	4.00	3.70	2.16	3.11
Reading Fluency Composite	0.17	1.07	-0.19	0.76
Phonological awareness[4]	9.67	4.36	9.37	3.73
Rapid Automatized Naming[5]	47.14	14.77	47.74	21.40
Phonological Memory[6]	9.43	3.33	8.21	3.39
Judgement task[7]	16.62	2.92	16.47	2.57
Analogy task[7]	6.52	3.98	5.68	4.04
Morphological Awareness Composite	0.06	0.72	-0.07	0.87

Note. Scores on all tasks are raw scores except for reading accuracy, reading fluency, and morphological knowledge which are composite scores. MRD refers to children with difficulties attending a monolingual school and BRD refers to children with reading difficulties attending a bilingual school.

[1] measured using reading tasks developed and used in Saiegh-Haddad & Taha's (2017) study out of 30 items

[2] measured using list of real words obtained from Tibi (2016)

[3] measured using list of nonwords obtained from the Nonword Reading Accuracy subtest from the Children's Standardized Phonological Processing Test (Arabic).

[4] measured using Elision subtest from the subtest from the Children's Standardized Phonological Processing Test (Arabic) out of 20 items

[5] measured using rapid letter naming subtest from the Children's Standardized Phonological Processing Test (Arabic)

[6] measured using nonword repetition subtest from the nonword repetition subtest from the Children's Standardized Phonological Processing Test (Arabic) out of 20 items

[7] measured using adapted tasks to measure morphological awareness out of 20 items

*($p < 0.001$) reliability was calculated by correlating the measures nonword and real word reading fluency using Spearman rho's correlations
** Cronbach's alpha reported in the Children's Standardized Phonological Processing Test manual

Appendix 12

Table summarizing spearman rho's correlations on all Arabic variables in Study 2

Table 1. Bivariate Correlations for Arabic Variables (N = 40)

Variable	1	2	3	4	5	6	7	8
1. Reading Accuracy Composite	—	.81**	.49**	.24	.66**	-.13	.04	-.14
2. Reading Fluency Composite		—	.51**	.17	.64**	-.31	-.06	0.13
3. Morphological Awareness Composite			—	.12	.49**	-.44**	.11	-0.09
4. Receptive Vocabulary				—	.04	.11	.16	-0.19
5. Phonological Awareness					—	-.08	.11	.14
6. RAN						—	.21	-0.03
7. Phonological Memory							—	-0.10
8. Age								—

*$p < .05$. **$p < .01$.

Appendix 13

Additional analyses comparing voweled and unvoweled reading among TD students and students with RD attending bilingual schools in Study 1

Non-parametric dependent samples tests (Wilcoxin signed-rank test) indicated the voweled reading accuracy scores *(Mdn = 7.00)* and unvoweled reading accuracy scores *(Mdn = 9.00)* did not differ for the children with RD, $z = -0.94$, $p = .35$. Non-parametric dependent samples tests (Wilcoxin signed-rank test) indicated lower voweled reading accuracy scores *(Mdn = 25.50)* than unvoweled reading accuracy scores *(Mdn = 27.00)* for the TD students, $z = -3.25$, $p = .001$.