Early oral language and cognitive predictors of emergent literacy skills in Arabic-speaking children: evidence from Saudi children with developmental language disorder

Early oral language and cognitive predictors of emergent literacy skills in Arabic speaking children: Evidence from Saudi children with developmental language disorder

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ABSTRACT

Purpose: Although children with developmental language disorder (DLD) are known to have difficulties with emergent literacy skills, few available studies have examined emergent literacy skills in Arabic speaking children with DLD. Even though Arabic language characteristics, such as diglossia and orthographic structure influence the acquisition of literacy in Arabic-speaking children, research shows that oral language skills, such as vocabulary, and cognitive skills, such as VSTM, predict literacy in Arabic-speaking children. Moreover, linguistic and memory abilities are impaired in children with DLD, including Arabic-speaking children. The current study examines the relationships between oral language, verbal short-term memory (VSTM), and emergent literacy skills in Arabic-speaking TD children and children with DLD.

Method: Participants were 40 typically developing (TD) children (20 girls; aged 4;0 to 6;11), and 26 children with DLD (9 girls; aged 4;0 to 6;11). All participants were monolingual Arabic speakers and matched on age and socioeconomic status. A set of comprehensive Arabic language (vocabulary knowledge, morphosyntactic, and listening comprehension skills), VSTM, and emergent literacy (phonological awareness, and letter knowledge skills) tests were administered.

Results: The DLD group scored significantly lower than the TD group on language, VSTM, and emergent literacy measures. Results revealed that the contributions of oral language and VSTM to emergent literacy skills across TD and DLD groups were different. In the TD group, VSTM predicted emergent literacy skills, whereas in the DLD groups, both vocabulary knowledge and VSTM predicted emergent literacy skills.

Conclusion: This study represents an important first step in understanding emergent literacy skills and their relationships to language and memory in Arabic-speaking children with and without DLD. The implications of these findings for clinical and education provision are discussed.

Keywords: Developmental language disorder, verbal short-term memory, emergent literacy, language skills, Arabic

Introduction

The process of learning to read begins in the early years of childhood, prior to formal reading instruction (Rhyner, 2009). Emergent literacy, also known as early literacy, reflects children's ability to understand reading and writing before they are considered readers and writers (Teale & Sulzby, 1986). Similar to language development, emergent literacy skills are acquired through an interactive and continuous process. As these skills emerge, they concurrently interact with early oral language skills, and an interrelationship between oral language skills and written language skills gradually appears and develops over time. Thus, emergent literacy acts as a link between early language skills and literacy skills (Rhyner, 2009). Different models have been suggested to provide researchers with frameworks describing emergent literacy components and how they are related to each other.

The simple view of reading (SVR) model (Gough & Tunmer, 1986) presents the reading process by defining the two essential interrelated components: decoding and language comprehension domains (Hoover & Tunmer, 2018a). Deficits in either of these elements may lead to poor reading comprehension. The reading rope model (Scarborough, 2001) supports the SVR model and advances it to include the underlying subskills of decoding (i.e., phonological awareness, letter knowledge, sight-word recognition), and language comprehension domains (i.e., background knowledge, vocabulary knowledge, language structure, verbal reasoning). The reading rope model also demonstrates how these subskills are related and influence each other's development, highlighting the importance of each subskill for reading comprehension.

The connectionist model (Seidenberg, 2005) emphasizes the importance of phonological representations to word recognition. It argues that word recognition is based on the connection between orthographic and phonological knowledge, and that this

connection allows the development of direct connections between orthographic and semantic knowledge.

Despite differences between the models discussed, all demonstrate how oral language and literacy skills are fundamentally related to each other – a hypothesis supported by numerous studies (Catts & Hogan, 2003; Psyridou et al., 2018; Snowling et al., 2016; Tambyraja et al., 2015; Wilson & Lonigan, 2010).

Children with developmental language disorder (DLD) are known to have language difficulties in one or more areas of language such as vocabulary and syntax (Leonard, 2014) which may affect their reading and writing skills, leading to academic difficulties (Botting, 2020; Boudreau & Hedberg, 1999; McGregor, 2020). McGregor (2020) reported that school-age children with DLD are six times more likely than their peers to have literacy and spelling difficulties. No study tested emergent literacy in Arabic-speaking children with DLD, neither has any research tested the role of oral language and memory skills to literacy in Arabic DLD. This question is particularly informative given the fact that in Arabic, and given the diglossic context (Albirini, 2016), children are required to develop literacy in a standard variety that is remarkably different from the spoken vernacular they use for everyday oral communication (Saiegh-Haddad, 2018). The current study investigates the contribution of oral language skills to emergent literacy skills in Arabic speaking young children aged 4;0 – 6;11 years old with and without developmental language disorder (DLD). In particular, we focus on the roles of different oral language skills: vocabulary knowledge, syntactic skills, morphological skills, and listening comprehension.

Verbal short-term memory (VSTM) is a cognitive skill which refers to the ability to listen and store information over a short period when other competing cognitive demands are absent (Gathercole et al., 2006; Jackson et al., 2020). Different studies have

reported that VSTM is correlated with reading skills in young children (Cunningham et al., 2020; Cunningham & Carroll, 2013; Layes et al., 2021). Numerous studies have shown that language difficulties in children with DLD are related to their memory deficits (Archibald & Gathercole, 2007; Montgomery et al., 2010; Ullman et al., 2020). Therefore, the study will also investigate the role of VSTM, alongside oral language skills, in emergent literacy development.

Linguistic and Cognitive Predictors of Emergent Literacy Skills

A growing body of research has highlighted the importance of oral language skills in the development of emergent literacy and later literacy skills (Catts et al., 2015; Dickinson et al., 2019; Kendeou et al., 2009; Lonigan et al., 2000; Muter et al., 2004). In a longitudinal study, Catts et al., (2015) used the SVR framework to examine the early predictors of reading comprehension. They followed the development of decoding-related skills (e.g., phonological awareness, letter knowledge) and oral language skills (e.g., narrative and vocabulary knowledge) in 336 children aged 5 to 9. They also assessed word reading skills at the end of their second grade (aged 8) and reading comprehension skills at the end of the third grade (aged 9). They found that at age 5, oral language skills were positively correlated with letter knowledge and phonological awareness. Additionally, second-grade word recognition skills were predicted by kindergarten phonological awareness and letter knowledge skills, while kindergarten oral language skills did not predict second-grade word recognition. Due to the strong associations between phonological awareness and oral language skills, Catts et al. suggested that children's phonological awareness skills act as a reflection of their language skills.

The crucial role of language skills on emergent literacy skills have been explored in various varieties of English and the results show that language and literacy skills are also related in different varieties of English. For example, Dickinson et al. (2019)

investigated the relationship between language (i.e., vocabulary, syntax, discourse, and spontaneous production) and decoding-related skills of 489 African-American children aged 4;5 years. They found that language and decoding-related skills are not separate during the early stages of literacy acquisition (emergent literacy stage). Consistent with the reading rope model (Scarborough, 2001), both skills are interrelated and influence the development of each other. Furthermore, they found that, of the language skills, vocabulary knowledge was the most important language predictor of phonological awareness and letter knowledge. This evidence supports the connectionist model which emphasizes the importance of the associations between semantic, phonological and orthographic knowledge (Seidenberg, 2005).

Vocabulary knowledge is crucial for language development and reading skills. It plays a foundational role in both decoding and comprehension (Ricketts et al., 2007; Suggate et al., 2018). During the early stages of decoding, children rely more on their semantic knowledge to facilitate the acquisition of the grapheme-phoneme mapping process (Seidenberg, 2005). Thus, vocabulary knowledge facilitates the acquisition of phonological awareness skills (Metsala & Walley, 1998). Phonological awareness has also been found to support vocabulary development (Anthony & Lonigan, 2004; Dickinson et al., 2019; Gillon, 2018).

Morphological awareness, which refers to the conscious ability to analyse words into their component morphemes (i.e., smallest meaningful units) (Nagy et al., 2014), contributes significantly to literacy acquisition (Dawson et al., 2017; Gillon, 2018; Green, 2009; James et al., 2020; Nagy et al., 2014). In a cross-sectional study, James et al. (2020) found that, in all age groups (6;0 to 8;11, 9;0 to 11;11, and 12;0 to 13;11), morphological awareness contributed significantly to reading comprehension skills above and beyond vocabulary, phonological awareness, word reading, and nonverbal reasoning. As a result,

155 they recommended including morphological awareness strategies in classroom-reading
156 instructions.

157 Listening comprehension refers to the ability to listen to and understand spoken
158 language. During the early years of development – before exposure to written language –
159 children's oral language comprehension skills are often tested using a listening
160 comprehension task (Hoover & Tunmer, 2018). Thus, listening comprehension is another
161 important component of reading comprehension (Gough & Tunmer, 1986). Both skills
162 are highly interrelated and tap into general language comprehension processes despite
163 their different modalities (Hoover & Tunmer, 2018; Wolf et al., 2019). Numerous studies
164 have included listening comprehension in language assessment together with other
165 language skills such as vocabulary and syntax and investigated the effect of these
166 variables on reading as one generic language construct (i.e., language comprehension).
167 Findings showed that children who had difficulties with language comprehension also
168 had difficulties with reading comprehension, despite having age-appropriate levels of
169 word reading fluency and accuracy (Foorman et al., 2015; Kendeou et al., 2009; Nation
170 et al., 2010; Storch & Whitehurst, 2002).

171 In addition to oral language skills, different cognitive skills such as verbal short-
172 term memory (VSTM) have also been found to contribute to the development of emergent
173 literacy skills. Numerous studies have shown that VSTM is the primary predictor of
174 phonological awareness in children (Cunningham et al., 2020; Layes et al., 2021;
175 Martinez Perez et al., 2012; McBride, 2015). Phonological awareness requires adequate
176 means of storage of phonological codes and an activation of phonological representations
177 to manipulate the syllabic or phonemic structures of the words. Therefore, any deficits in
178 VSTM may hinder the acquisition of phonological awareness skills. VSTM is
179 traditionally measured by digit span recall or nonword repetition tasks. It should be noted

that these two tasks address different underlying VSTM skills. Digit span recall examines the ability to process the order of information given (i.e., order VSTM), while nonword repetition tasks assess the ability to process the information's items (i.e., item VSTM) (Majerus et al., 2008; Martinez Perez et al., 2012). Martinez Perez et al. (2012) conducted a longitudinal study to examine the relationship between VSTM and decoding skills in 74 children of kindergarten age (mean age = 5;8) in the US. They found that order VSTM, but not item VSTM, significantly predicted decoding skills in first grade. This finding was attributed to the role of order VSTM capacities in acquiring new phonological representations. When reading a new word (i.e., decoding), children must link different graphemes to their corresponding phonemes in a particular order, then temporarily store this coded sequence to read it out. Cunningham et al. (2020) investigated the effect of memory on reading development in children aged 4, 5, 6, and 9. They found that VSTM measured by digit span and phonemes repetition directly predicted word-level reading in children aged 4 to 6, and indirectly via phonological awareness skills; furthermore, VSTM when measured by nonword repetition predicted word-level reading in children aged 6 to 9. This could be explained through knowledge that during early stages of decoding, children rely more on their serial order VSTM to learn how to translate the graphemes into their corresponding phonemes. Once children become proficient decoders, they start to rely more on other linguistic and metalinguistic skills that are crucial for reading comprehension. Similar findings were also reported in children with reading difficulties (Hachmann et al., 2014)

Emergent Literacy Skills in Typically Developing Arabic Speaking Children

Arabic is the official language of 27 countries and is spoken by over 300 million people in the world (Hermena & Reichle, 2020; Saiegh-Haddad, 2018). It belongs to the Semitic language family (e.g., Hebrew, Amharic, and Maltese) and uses an abjad writing

system (i.e., consonantal orthographical system) (Daniels, 1992). The Arabic script is cursive and is written from the right to left. Because the script is cursive, the shape of letters differs depending on their placement in words (i.e., initial, medial, final following a connecting letter, and final following a non-connecting letter). See Saiegh-Haddad and Henkin-Rotifarb (2014) for more on the structure of Arabic language and orthography. Arabic orthography is considered semi-transparent (i.e., mixed) because it includes both vowelized and non-vowelized scripts (Hermena & Reichle, 2020). Vowelized scripts representing mainly short vowels and consonant germination/doubling – those with diacritical markers – are used only in children's books, poetry, and the Qur'an. Non-vowelized scripts require the reader to rely on linguistic knowledge including the word's derivational morphological structure (i.e., root and pattern) and morpho-syntactic properties, as well as sentence context to identify words (Saiegh-Haddad, 2018). Like Hebrew, Arabic is a morpheme-dense language and depends on its root-derived word composition (i.e., root and pattern morphemes are linked in words). Arabic is commonly known as a diglossic language in which speakers use two different varieties of the same language in different contexts and for different functions (Ferguson, 1959); Spoken Arabic (SpA) for everyday speech and Modern Standard Arabic (MSA or StA) for formal functions and for reading/writing (Saiegh-Haddad, 2018). So, how do the unique characteristics of the Arabic language affect reading acquisition in children?

In the sociolinguistic context of Arabic diglossia, children are only exposed to SpA during the early years of their development, before they enter school. They begin to learn MSA mainly once they start school and are exposed to formal reading instruction (Ayari, 1996). This may pose a challenge to children while learning to read (Saiegh-Haddad, 2022). Research might have found that diglossia has a negative impact on literacy acquisition in Arabic-speaking TD children (Asaad & Eviatar, 2013; Asadi &

Abu-Rabia, 2021; Saiegh-Haddad, 2005, 2022). For instance, Saeigh-Haddad and colleagues tested the role of the linguistic distance between SpA and MSA and found that linguistic distance impacted the establishment of phonological representations for MSA words. The linguistic distance between SpA and MSA was found to impact phonological processing in memory (Saiegh-Haddad & Ghawi-Dakwar, 2017), and it has been found to delay phonological awareness development in Arabic-speaking children (Saiegh-Haddad, 2003, 2004, 2007; Saiegh-Haddad et al., 2020), morphological awareness (Schiff & Saiegh-Haddad, 2018) and word reading (Saiegh-Haddad & Schiff, 2016). The researchers argue that these effects of linguistic distance are grounded in linguistic representations and difficulty establishing and accessing MSA linguistic structures given limited early exposure and use of MSA among children (Saiegh-Haddad, 2018; Saiegh-Haddad et al., 2022).

Moreover, the complexity of the Arabic orthography is an additional challenge for Arabic-speaking children during literacy acquisition. Asaad and Eviatar, (2013) and Khateb et al. (2014) suggested that the visual complexity of Arabic graphemes might slow down reading acquisition in children. Other studies have emphasized the importance of vowel diacritics on reading accuracy in children and found that vowels act as a facilitator for word-reading in both skilled and unskilled readers (Abu-Rabia, 2007). Others argue that vowel diacritics are only needed among beginning readers (Saiegh-Haddad & Schiff, 2016; Schiff & Saiegh-Haddad, 2017), yet they disrupt reading accuracy and fluency after the second grade (Saiegh-Haddad, 2018). Given the linguistic and orthographic properties of Arabic, as well as the diglossic context of language acquisition and use, it is important to further understand emergent literacy skills development in Arabic speaking children and the relationships between emergent literacy, on the one hand, and cognitive and linguistic skills, on the other hand.

Asadi, Khateb, and Shany (2017) examined the contribution of the oral language linguistic component of the SVR model in the Arabic language. Based on the unique characteristics of the Arabic language, they predicted that orthographic knowledge and morphological knowledge would contribute to reading comprehension more than decoding. Consistent with their prediction, the authors found that decoding was not a significant predictor of reading comprehension when orthographic and morphological knowledge were added to the model. Their findings confirmed the validity of the SVR in Arabic, but also highlighted the need to consider the unique Arabic characteristics when assessing children's literacy.

The unique contribution of morphological awareness to Arabic reading was also documented in Schiff and Saiegh-Haddad's (2018) study which examined the contributions of phonological awareness and morphological awareness skills to word-reading skills in school-aged Palestinian Arabic-speaking children in the 2nd thorough the 10th grades. Findings indicated that morphological awareness skills were significant predictors of word reading even after controlling for grade levels and phonological awareness skills. Similar results were also noted in previous studies confirming the crucial role of morphological skills in literacy acquisition in Arabic (Abu Ahmad et al., 2014; Abu-Rabia, 2007; Abu-Rabia & Siegel, 2002; Asadi, Khateb, & Shany, 2017; Saiegh-Haddad & Taha, 2017; Taha & Saiegh-Haddad, 2017).

With regards to VSTM, Saiegh-Haddad (2005) showed that this ability, tested using the digit Span task (forward and backward), predicted word decoding fluency in the first grade, alongside colour rapid naming and speed of letter-sound recording. Similarly, recent evidence demonstrates the crucial role that VSTM plays in acquiring literacy skills in children. For example, Asadi, Khateb, Ibrahim, et al. (2017) found that VSTM, as measured by digit span testing and phonological working memory testing (i.e.,

backward digit span), contributed significantly to decoding and reading fluency skills. Similar findings were reported by Hassanein et al. (2021) who found that VSTM, measured by a digit span task, was a significant predictor of decoding skills in first and second graders from Qatar.

Emergent Literacy in Children with Developmental Language Disorder

Developmental language disorder (DLD) is a heterogeneous neurodevelopmental disorder that emerges in early childhood and persists into adulthood. It affects approximately 7.5% of children (Norbury et al., 2016) and is characterized by language difficulties with no known differentiating condition such as autism spectrum disorder, cerebral palsy, brain injury, or sensorineural hearing loss (Bishop et al., 2016, 2017). These difficulties may affect one or several language domains including phonology, morphology, syntax, semantics, and/or pragmatics. Language difficulties have been related to delayed emergent literacy skills in children with DLD, with studies documenting that these children are also at risk of having emergent and later literacy difficulties (Catts & Hogan, 2003; Catts & Kamhi, 2005; Pratt et al., 2020; Snowling et al., 2016; Tambyraja et al., 2015; Thatcher, 2010).

Tambyraja et al., (2015) documented significant difficulties with alphabet knowledge, print knowledge, and rhyme awareness in children with DLD, with 75- 80% of children with DLD being reported at risk of emergent literacy difficulties. Snowling et al. (2016), in their longitudinal study, followed 220 children at risk of dyslexia and with language difficulties from preschool to middle childhood. They identified three developmental trajectories: resolving language impairment (LI), emerging LI, and persistent LI, and explored the effect of language deficits on literacy acquisition among these groups. Consistent with the previous evidence, results demonstrated that emerging language impairment (LI) and persistent LI groups performed significantly lower than the

TD group on all literacy-related measures (i.e., letter knowledge, phoneme awareness, rapid automatized naming, and single word reading) at ages 5;6 and 8. However, the resolving LI group performed at a similar level to their TD peers on all literacy related measures. Snowling et al. (2016) explained the findings by referring to the critical age hypothesis (Bishop & Adams, 1990). Children who have language difficulties that are present at the time of formal reading instruction, as observed in the emerging LI and persistent LI groups, are at substantial risk of literacy difficulties. On the other hand, children whose language difficulties resolve before formal reading instructions, as observed in the resolving LI group, are at a lower risk. Another interesting finding was that 48% of the emerging LI group and 41% of the persistent LI group were diagnosed with dyslexia at age 8.

Emergent Literacy Skills in Arabic-Speaking Children with Developmental Language Disorder

There is emerging evidence that Arabic children with DLD have difficulties with phonological processing skills and verbal short-term memory (Saiegh-Haddad & Ghawi-Dakwar, 2017; Taha et al., 2021b, 2021a), morphological and morpho-syntactic skills (Abdalla et al., 2013; Abdalla & Crago, 2008; Shaalan, 2017, 2020a; Taha et al., 2020), listening comprehension (Asadi et al., 2022; Shaalan, 2017), vocabulary skills (Shaalan, 2017), and narrative skills (Rakhlin et al., 2020).

A limited number of studies have examined emergent literacy skills in children with language difficulties and reading difficulties. In a recent longitudinal study, Mansour-Adwan et al. (2023) examined the relationships between different linguistic profiles of children in kindergarten and their reading skills in the first grade. Based on the two-dimensional model (Bishop & Snowling, 2004), children were grouped into four linguistic groups: low language (111 children), low phonology (120 children), low

language and low phonology (139 children), and typical language and typical phonology (135 children). Their findings highlighted the importance of phonological and language skills for reading and significant differences in reading performances among the different linguistic groups. Children with low language and low phonology skills obtained lowest scores on reading when compared with the other groups. Alsiddiqi et al., (2021) compared the emergent literacy skills in TD children and children with DLD aged between 4;0 – 6;11 years old. They found that, compared to the TD group, the children with DLD had significantly lower scores on syllable segmentation, phoneme awareness, and emergent literacy composite. Vocabulary knowledge and syntactic skills were significantly positively correlated with emergent literacy composite scores in the TD group, while all oral language skills (i.e., vocabulary knowledge, syntactic skills, morphological skills, listening comprehension and mean length per utterance) were positively significantly correlated to emergent literacy composite scores in the DLD group.

VSTM received more attention in literacy skills development in children with reading difficulties. For example, Elbeheri and Everatt (2007) tested working memory skills in 332 children (40 children with dyslexia and 292 TD children) aged 9;4 to 11;6. They reported significant differences between TD children and children with dyslexia on the working memory test. Yet, the correlation analyses demonstrated weak associations between working memory and reading skills in the TD group, and no associations were found between working memory and reading skills in the dyslexic group. Lack of associations in the TD group could be explained by the participants' age, with the average age being 10;5. In the dyslexic group, lack of associations could be explained due to the severity of their decoding skill deficit, which may mask the importance of working memory skill. In contrast to previous findings, Zayed et al. (2013) found significant

355 correlations between working memory and PA skills, such as rhyme detection, syllable
356 blending, phoneme isolation, and phoneme blending tests in 40 preschool children (20
357 TD and 20 children at risk of literacy difficulties; their mean age was 5;6).

358 Given the unique linguistic and orthographic properties of Arabic, as well as its
359 unique diglossic sociolinguistic context, the study aims to investigate the role of linguistic
360 and cognitive skills in emergent literacy in Arabic-speaking children. Given observed
361 difficulties in linguistic and cognitive skills in Arabic-speaking children with DLD, the
362 second aim of the study is to compare the development of these abilities and their
363 relationship with emergent literacy in children with TD and DLD. The study addresses
364 the following research questions:

365 1. What is the contribution of oral language skills to emergent literacy skills in Saudi
366 Arabic speaking children with and without DLD?
367 2. What is the contribution of VSTM to emergent literacy skills in Saudi Arabic
368 speaking children with and without DLD?

Based on the existing literature, we predicted that linguistic skills such as vocabulary knowledge and syntactic skills would make significant contributions to emergent literacy skills in TD and DLD groups. Since numerous studies have shown significant correlations between different VSTM measures and emergent literacy skills, we predicted that digit recall and nonword repetition skills would be related to emergent literacy skills in TD and DLD groups.

Method

The study was approved by the XXXXX (blinded for review purposes), and the Higher Ministry of Education in Riyadh, Saudi Arabia. We used a between-groups design to compare between the typically developing (TD) group and children with DLD group.

Participants

Sixty-six Saudi children aged 4;0 – 6;11 were recruited for the study. According to parental report, none of the children had a history of hearing loss or cognitive, motor, behavioural, or neurological disorders. There were 26 children with DLD (17 boys and nine girls) aged between 4;0 – 6;11 years old (mean age = 62.73 months, *SD* = 10.77 months), recruited from a speech and language clinic at XXXX and XXX (blinded for review purposes). These children were diagnosed with DLD by a qualified speech-language therapist (SLT) and had been receiving speech and language therapy. Since standardized Arabic language assessments are not available, it was crucial to ensure that children with DLD met criteria for DLD (Bishop et al., 2016). Inclusionary criteria for this group were (1) a diagnosis of developmental language disorder, and (2) no known differentiating condition (e.g., brain injury, cerebral palsy, sensorineural hearing loss, autism, and other genetic conditions). There were 40 TD children (20 boys and 20 girls) aged between 4;0 – 6;11-year-old, (mean age= 65.45 months, *SD* = 9.37 months), recruited from four public kindergartens. The additional inclusionary criteria for this

group were: (1) age-appropriate language skills as reported by their parents, (2) no hearing impairment, (3) no history of speech, language or communication disorder, and (4) no other neurological, social, emotional, behavioural, emotional or sensory disorders. All parents of potential participants were asked to sign consent forms and fill demographic and developmental history questionnaires. The two groups did not differ significantly on chronological age, $U = 432$, $z = -1.16$, $p = .248$, and did not differ in their nonverbal abilities as measured by the Colored Progressives Matrices (CPM; Raven, 2007), $U = 420$, $z = -1.32$, $p = .188$. To measure socioeconomic status, parents completed a demographic questionnaire including parental educational level, parental occupation, and family income. These three main socioeconomic components are known to influence parents' input and interactions with their children (Rowe, 2018). See Table 1 for demographic information for both groups of participants.

Table 1. *Participants' demographic characteristics*

INSERT TABLE 1 AROUND HERE

Materials

A comprehensive Arabic language and emergent literacy test battery was administered. We used the Arabic language battery, and the Arabic emergent literacy battery as described in Alsiddiqi et al., (2021). The Arabic language battery composed of (a) Arabic Receptive Vocabulary Test (Shaalan, 2010), (b) Arabic Expressive Vocabulary Test -2 (AEVT-2), (c) Arabic Sentence Imitation Task (ASIT), (d) listening comprehension test, and (e) spontaneous language sample. The emergent literacy battery included (a) phonological awareness tests, and (b) letter knowledge test. Since most children in the current study were only exposed to the spoken Arabic (SpA) dialect, and to control for the diglossia effect (Saiegh-Haddad, 2018), all tests were administered using SpA.

General cognitive ability and verbal short-term memory tests were also administered. Children's nonverbal reasoning abilities were tested using the Raven's Coloured Progressive Matrices (CPM) (Raven, 1998). To assess the serial order VSTM and the item order VSTM, digit recall and nonword repetition tests were used.

Procedure

Each child was assessed in a quiet room in the nursery, school, or speech and language therapy clinic. All assessments were conducted in two to three sessions depending on the participant's age and motivation. Younger children (i.e.,4;0 – 4;11 years old) often required more than one session due to their lower attention span. Each session lasted approximately 1 hour and was audio recorded using Sony ICD-UX560F digital voice recorder. The tests were administered in the following order: general cognitive ability, VSTM tests, the Arabic language battery, and the Arabic emergent literacy battery. Typically developing children were also required to complete the hearing screening in order to rule out any hearing deficits. DLD children had already completed a hearing screening test prior to their diagnosis. To engage participants during testing, each child was provided with a task rewards chart to complete as a motivation for participation. They received a big sticker when they completed the chart. All tests were administered by the 1st author, who is a qualified speech and language therapist.

Reliability

Interrater reliability was established by having a second qualified Saudi Arabic-speaking speech and language therapist who independently scored the responses of 15 children (23% of the sample). According to Cicchetti (1994), intraclass correlation coefficient (ICC) values from .60 to .74 indicate good levels of agreement and values from .75 to 1.0 indicate excellent levels of agreement. For the language assessments, ICC values were excellent, for receptive vocabulary (α = 1.0), expressive vocabulary (α = .99), listening

443 comprehension (α =.99), sentence repetition (α = 1.0), and mean morpheme per utterance
444 (MPU) (α = 1.0). For the emergent literacy assessment, ICC values were excellent for
445 syllable segmentation, phoneme awareness, letter knowledge, and decoding (α = 1.0).
446 Finally, ICC values were also excellent for nonword repetition and digit recall (α = 1.0).

447 ***Analysis***

448 All descriptive and inferential statistical analyses were performed using IBM SPSS
449 Statistics, version 27. Raw scores were converted to percentages, and composite scores
450 of vocabulary knowledge (i.e., receptive and expressive vocabulary tests), listening
451 comprehension (i.e., inferential and literal questions), phoneme awareness (i.e., phoneme
452 isolation and deletion tests), letter knowledge (i.e., letter naming and letter sound tests),
453 and emergent literacy (i.e., syllable segmentation, phoneme awareness, and letter
454 knowledge) were obtained. Prior to the main analyses, Shapiro-Wilk's test was used to
455 test the normality of the distributions. Results revealed non-normal distribution of data (p
456 $< .05$), and therefore, nonparametric tests were used. First, we looked at the relationships
457 between oral language skills, VSTM, and emergent literacy skills. Then, we examined
458 the relative contributions of oral language and VSTM measures in predicting emergent
459 literacy skills in both groups. As a result, Spearman's rank order correlation coefficient
460 controlling for age was carried out first, and then we used hierarchal regression analyses
461 to address each research question. Significance levels were set at $p < .05$.

462 **Results**

463 This study aimed to examine the relative contributions of language and VSTM measures
464 to emergent literacy skills in TD and DLD groups. Descriptive data for each group is
465 presented in Table 2.

466 INSERT TABLE 2 HERE

Research Question 1: Oral language predictors of emergent literacy skills in Arabic

Our first research question sought to examine the role of language measures in predicting emergent literacy skills. Following the Spearman's rank correlation coefficient controlling for age– which has been carried out previously in Alsiddiqi et al., (2021), hierarchical multiple regression analyses were carried out using the emergent literacy composite score as the dependent variable. A power analysis revealed that a sample size of 26 was needed to achieve a large effect size with a p value of 0.05 based on 4 predictors. In the first model age and nonverbal reasoning skill were entered as covariate variables. In the second and third models, vocabulary knowledge and syntactic skills were added respectively to investigate their significant contribution to explaining variance in emergent literacy skills. Vocabulary knowledge was entered first because it is one of the earliest acquired oral language skills and showed higher correlations with emergent literacy skills in the DLD group (Alsiddiqi et al., 2021). Results of regression analyses for the TD group and the DLD group are presented in Table 3 and Table 4 respectively.

INSERT TABLE 3 and 4 HERE

Results of the regression analyses demonstrated that age was the only predictor that contributed significantly to emergent literacy skills in the TD group. However, results of regression analyses for the DLD group were different. As Table 4 shows, the first model, which included age and nonverbal reasoning skills as predictors, was significant [$F(2,23) = 9.301$, $p < .001$], with $R^2 = .447$. Nonverbal reasoning skills was the only significant predictor: $\beta = .452$, $t = 2.628$, $p = .015$, explaining 45% of variance. The second model, which included vocabulary knowledge as a predictor, was also significant [$F(3,22) = 8.758$, $p = .041$], with $R^2 = .544$, and accounted for an additional 7.5% of variance. The third model, which included syntactic skills as a predictor, was not

492 significant [$F(4,21) = 8.523$, $p = .056$], with R^2 change = .075. Overall, the regression
493 analyses demonstrated that vocabulary knowledge contributed significantly to emergent
494 literacy skills beyond age, non-verbal reasoning and syntactic skills in the DLD group in
495 the sample.

496 ***Research Question 2: VSTM predictors of emergent literacy skills in Arabic***

497 To examine the relationship between VSTM– as measured by digit recall (order
498 VSTM) and nonword repetition (item VSTM) tests – and emergent literacy skills in the
499 TD and DLD groups, we performed Spearman's rank correlation coefficient controlling
500 for age within each group. As Table 5 shows, results were different for the two groups.
501 In the TD group, only digit recall was found to be significantly correlated with an
502 emergent literacy composite. While, in the DLD group, digit recall, and nonword
503 repetition tests were both significantly correlated with the emergent literacy composite.
504 INSERT TABLE 5 HERE

505 To examine the relative contributions of these measures in predicting emergent
506 literacy skills in the DLD group, hierarchical multiple regression analyses were carried
507 out using the emergent literacy composite score as the dependent variable. A power
508 analysis revealed that a sample size of 26 was needed to achieve a large effect size with
509 a p value of 0.05 based on 4 predictors. An emergent literacy composite score was used
510 as the dependent variable, and in the first model age and nonverbal reasoning skill were
511 entered as covariate variables. In the second and third models, digit recall and nonword
512 repetition were added respectively to investigate their significant contribution to
513 explaining variance in emergent literacy skills. Digit recall was entered first because it
514 showed higher correlations with emergent literacy skills in both groups.

515 As Table 6 shows, similarly to the previous analyses (see Table 4) the first model
516 was significant and nonverbal reasoning skills were the only significant predictor

explaining 45% of variance. The second model, which included digit recall as a predictor, was also significant [F (3,22) =17.375, $p < .001$], with $R^2 = .691$, and accounting for an additional 24% of variance. The third model, which included nonword repetition as a predictor, was not significant [F (4,21) =.871, $p = .361$], with $R^2 = .703$. Overall, results of the regression analyses demonstrated that digit recall was the only predictor that contributes significantly to emergent literacy skills beyond age, nonverbal reasoning, and nonword repetition in the DLD group.

INSERT TABLE 6 HERE

Discussion

The main aim of this study was to examine the relative contributions of language and VSTM measures in predicting emergent literacy skills in Saudi Arabic-speaking children with and without DLD aged 4;00 to 6;11. Two major findings have emerged from this study. Firstly, vocabulary knowledge was found to be a significant predictor of emergent literacy skills in the DLD group but not in the TD group. Secondly, digit recall was found to be a significant predictor of emergent literacy skills in both TD and DLD groups. These findings are discussed below.

Oral Language and Emergent Literacy Skills in TD children and children with DLD

The first research question aimed to assess which of the oral language skills measured (i.e., vocabulary knowledge, morphosyntactic, and listening comprehension skills) were the most important predictors of emergent literacy skills (i.e., phonological awareness and letter knowledge) in TD children and those with DLD. The key finding was that variables were related in different ways in each group. In the TD group, the regression analyses revealed that none of the oral language measures were significant predictors of emergent literacy skills. This finding does not align with earlier research in other languages (Catts et al., 2016; Dickinson et al., 2019) and in a sample of Saudi-

speaking children similar to the one targeted in this study (Alsiddiqi et al., 2021) in which it was found that vocabulary knowledge and syntactic skills were correlated with emergent literacy skills. The mixed results may be related to the fact that in the current study a different analysis was used (a hierarchical multiple regression) which allowed for the unique contribution of each variable to be separately determined. This includes the contribution of age which might explain this finding in our sample. Previous research has shown that the associations between oral language and emergent literacy skills in the early years are significantly strong, but these relationships may weaken as children get older (Kendeou, van den Broek, et al., 2009; Storch & Whitehurst, 2002). Kendeou et al. (2009) reported that oral language skills (i.e., vocabulary knowledge and listening comprehension) predicted emergent literacy skills (i.e., phonological awareness and letter identification) at age 4, but this predictive power diminished when children reached the age of 6. In our sample, the mean age of the TD group was 65 months which is closer to age 6 than age 4. The current findings hence imply that oral language skills may not predict emergent literacy skills in children who are over the age of 5.

In the DLD group, when comparing all measured language skills, hierarchical multiple regression analyses demonstrated that only vocabulary knowledge, at this early stage of literacy development, was a significant predictor of emergent literacy skills, which suggests that it is important for emergent literacy skills development in children with DLD. This is in line with studies suggesting that the growth of phonological awareness skills is strongly related to the growth of vocabulary knowledge during the preschool years (Carroll et al., 2003; Hipfner-Boucher et al., 2014; Ventura et al., 2007). Findings such as these support the lexical restructuring model (Metsala & Walley, 1998) and the connectionist model (Seidenberg, 2005). Children during the early stages of development begin to acquire words as whole phonological units. Then, gradually as they

learn more words, the expansion of their vocabulary size enhances their phonological sensitivity, and they become more aware of the phonemes in words.

Verbal Short-Term Memory and Emergent Literacy Skills

The second research question focused on whether VSTM – as measured by digit recall and nonword repetition tests – was related to emergent literacy skills in the TD and DLD groups. Based on the existing literature on different languages (Cunningham et al., 2020; Gorman, 2012; Layes et al., 2021; Martinez Perez et al., 2012), we predicted that VSTM – as measured by digit recall and nonword repetition – would be a significant predictor of emergent literacy skills in both groups. Results of the correlational analyses demonstrated that variables were related in different ways in each group. In the TD group, only digit recall was significantly correlated with emergent literacy and explained unique variance in emergent literacy skills. In the DLD group, correlational analyses showed that both digit recall and nonword repetition were significantly positively correlated with emergent literacy skills, but only digit recall was found to explain unique variance in emergent literacy skills. Consistent with various studies (Cunningham et al., 2020; Ehri, 2017; Hachmann et al., 2014; Martinez-Perez et al., 2012), these findings demonstrate that different aspects of VSTM (i.e., serial order VSTM and item VSTM) are separable as they showed different relationships with emergent literacy skills. Serial order VSTM, as measured by digit recall, appears to be a significant predictor of emergent literacy skills during the early stages of development (ages 4 to 6). During the early stages of decoding, children begin to learn how to link different graphemes to their corresponding phonemes in a particular order. This early stage of development demands that children rely more on their serial order VSTM. Once they acquire their decoding skills, they begin to rely more on other linguistic and metalinguistic skills that are important for later literacy skills. In the current study, most of the children (aged 5 and 6) had not yet acquired decoding skills

592 at the time of being tested, which explains the significant role of digit recall in emergent
593 literacy skills in TD and DLD groups.

594 In the DLD group, and unlike in TD children, nonword repetition was found to be
595 significantly associated with emergent literacy skills beyond digit recall. Earlier research
596 reported that children with DLD are outperformed by their age-matched TD peers on
597 nonword repetition (Saiegh-Haddad & Ghawi-Dakwar, 2017). Moreover, nonword
598 repetition in children with DLD was found in this same study to be more strongly
599 impacted by phonological distance that in the TD children arguably reflecting low quality
600 phonological representations for MSA phonological structures. As emergent literacy in
601 the current study was tested, among other tasks, by a letter knowledge task, and as some
602 of the Arabic letters represent phonemes that are not within the spoken vernacular of
603 children (e.g., phoneme /dˤ/ and /q/ in MSA are substituted with /ðˤ/, and /g/ respectively
604 in the Saudi dialect spoken by children), it might be argued that this contributed to the
605 observed significant relationship between nonword repetition and emergent literacy in the
606 children with DLD (Saiegh-Haddad & Armon-Lotem, 2024). There is also overwhelming
607 evidence of limited processing capacity skills in children with DLD (Leonard, 2014).
608 Children with DLD are frequently reported to have difficulties with VSTM, in particular
609 nonword repetition, which has been identified to be one of the clinical markers of DLD
610 (Conti-Ramsden & Durkin, 2007; Jackson et al., 2020; Norbury et al., 2008; Shaalan,
611 2020; Taha et al., 2021a). Due to the limited processing skills in DLD children, more
612 demands are placed on all the cognitive resources that those children have, resulting in
613 stronger relationships between all skills in general, and particularly between VSTM (i.e.,
614 nonword repetition and digit recall) and emergent literacy skills. Despite this, as discussed
615 above, only serial order VSTM (i.e., digit recall) was found to be a significant predictor
616 for emergent literacy skills in the DLD group. In terms of studies evaluated within the

wider context of Arabic literacy research, our findings support those reported Asadi, Khateb, Ibrahim, et al. (2017), Hassanein et al. (2021), Saiegh-Haddad (2005) on the crucial role of VSTM on emergent literacy skills in Arabic-speaking children and extended their findings by examining the effect of different underlying VSTM processing skills (i.e., serial order VSTM measured by digit span, and item VSTM measured by nonword repetition) on emergent literacy skills in Arabic-speaking children. Thus, this study's evidence highlighted the importance of the serial order VSTM on emergent literacy skills in TD and DLD Arabic-speaking children.

Limitations

Findings of this study should be interpreted with caution due to the following limitations. First, small sample sizes in both groups and differences in socioeconomic status that have not been controlled for may constrained our results. Future studies should recruit larger sample sizes to replicate the existing findings so more definitive conclusions can be drawn. Also, future research is needed to highlight the importance of the socio-cultural context on emergent literacy development among Arabic speaking children. Second, the study uses a cross-sectional design. To have more accurate understanding of the relationship between oral language and emergent literacy skills, future studies should include longitudinal designs and investigate this relationship across different time points. Third, the DLD group had a smaller sample size than the TD group. Future studies should include larger and more balanced sample sizes in both groups to increase statistical power and generalisability of results. In term of procedure, some children completed all the assessments in a single session of up to one hour. However, due to the age and attention levels of some of the children, the protocol was completed over 2-3 sessions. For more consistent assessments' delivery, future studies should control number of sessions, and administer less assessments. Also, it should be noted that multiple correlations were

carried out, such that, by chance, 1 in 20 may be significant due to chance. Finally, most of the administered tasks were not standardized on Saudi Arabic-speaking children. Further validation of these tasks is required for research and clinical purposes.

Clinical Implications

This study fills a crucial gap in knowledge by examining the the relative contributions of language and VSTM measures in predicting emergent literacy skills in Arabic-speaking children. Comparing Arabic-speaking DLD children with their TD peers has provided a preliminary insight into their emergent literacy skills. This insight will facilitate the advancement of knowledge into different oral language factors that may contribute to emergent literacy acquisition. Literacy difficulties are common, affecting 3% to 10% of students (Snowling & Hulme, 2013) who are often referred to special educational teachers for support. However, despite this significant support, most educators are not fully aware of the relationships between oral language and literacy skills, as well as the importance of referring those students to SLTs for a comprehensive language assessment. In Saudi Arabia, most educators are only familiar with dyslexia, which is caused by phonological processing deficits (Adlof & Hogan, 2018). These deficits are more apparent than DLD (McGregor, 2020). As a result, children with phonological processing deficits are more likely to receive SLT services. DLD, on the other hand, is known to be a hidden disorder and is consequently underserved and relatively unknown. Children with DLD are known to have language difficulties in one or several language domains, including phonology, morphology, syntax, semantics, and/or pragmatics. Thus, any needs in these domains may affect the acquisition of children's literacy skills, resulting in hyperlexia (i.e., difficulties with language comprehension) or garden variety reading difficulties (i.e., difficulties with both decoding and language comprehension; Catts, 2018). Therefore, this study strongly recommends

667 educators be made familiar with DLD and understand the impact of different language
668 needs in children's academic skills. The collaboration between SLTs and educators is
669 very important as it helps to identify students' receptive and expressive language skills,
670 and to understand how they are using their linguistic skills in academic settings in general
671 – literacy in particular (Justice, 2006; Squires et al., 2013). Educators should be mindful
672 of possible links between oral language, VSTM and emergent literacy skills and, where
673 literacy difficulties are identified, refer to SLTs to assess a student's language skills and
674 access appropriate support when needed.

675 ***Conclusion***

676 This study offers a valuable contribution to the field's knowledge regarding
677 Arabic-speaking children with DLD. It represents an important step in understanding
678 emergent literacy skills and their relationships to language and VSTM in Arabic-speaking
679 children with and without DLD. Findings are consistent with different theoretical
680 frameworks (Gough & Tunmer, 1986; Scarborough, 2001; Seidenberg, 2005), which
681 suggest significant associations between oral language and emergent literacy skills in
682 both groups. In fact, these associations are more evident in the DLD group due to their
683 oral language deficits. Like the reading rope model (Scarborough, 2001), results in the
684 DLD group show how different oral language skills are interrelated with different
685 emergent literacy skills, and that the development of one skill is influencing the other.
686 Results also indicate the importance of vocabulary knowledge for emergent literacy
687 acquisition (Seidenberg, 2005).

688 Regarding VSTM, this study's preliminary results demonstrate that different
689 aspects of VSTM (i.e., serial order VSTM and item VSTM) are separable – as made
690 evident by their different relationships with emergent literacy skills in TD and DLD
691 groups. This study's findings reveal that serial order VSTM, as measured by digit recall,

is more important on emergent literacy acquisition than item VSTM, as measured by nonword repetition, during the early stages of development in Arabic-speaking children aged 4;0 to 6;11 with and without DLD. At the same time, nonword repetition seems to be more implicated in emergent literacy in children with DLD than in TD children as the correlational analysis shows, and this may be related to the phonological distance in Arabic diglossia (Saiegh-Haddad, 2022) and stronger effects of distance in children with DLD (Saiegh-Haddad & Ghawi-Dakwar, 2014; Saiegh-Haddad & Armon-Lotem, 2024). This question, however, remains open for future research.

To summarise, this study blazes a trail for future research into the relationship between oral language and early literacy skills in the Arabic language, and thus also paves the way for boosting the clinical and education provision that children with DLD receive.

Data Availability Statement

The data sets analysed that support the findings of this study are available at https://doi.org/10.17864/1947.000418

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Author Notes Declaration of interest

Disclosure: The authors report no declarations of interest.

References

Abdalla, F., Aljenaie, K., & Mahfoudhi, A. (2013). Plural noun inflection in Kuwaiti Arabic-speaking children with and without Specific Language Impairment. *Journal of Child Language*, *40*(1), 139–168. https://doi.org/10.1017/S0305000912000499

Abdalla, F., & Crago, M. (2008). *Verb morphology deficits in Arabic-speaking children with specific language impairment*. *29*, 315–340. https://doi.org/10.1017/S0142716408080156

Abu-Rabia, S. (2007). The role of morphology and short vowelization in reading arabic among normal and dyslexic readers in grades 3, 6, 9, and 12. *Journal of Psycholinguistic Research*, *36*(2), 89–106.

Adlof, S. M., & Hogan, T. P. (2018). Understanding dyslexia in the context of developmental language disorders. *Language, Speech, and Hearing Services in Schools*, *49*(4), 762–773. https://doi.org/10.1044/2018_LSHSS-DYSLC-18-0049

Albirini, A. (2016). *Modern Arabic Sociolinguistics: Diglossia, variation, codeswitching, attitudes and identity*. Routledge.

Alsiddiqi, Z. A., Stojanovik, V., & Pagnamenta, E. (2021). Emergent literacy skills of Saudi Arabic speaking children with and without developmental language disorder. *Clinical Linguistics & Phonetics*, 1–18. https://doi.org/10.1080/02699206.2021.1955299

Anthony, J. L., & Lonigan, C. J. (2004). The Nature of Phonological Awareness: Converging Evidence From Four Studies of Preschool and Early Grade School Children. In *Journal of Educational Psychology* (Vol. 96, Issue 1, pp. 43–55). https://doi.org/10.1037/0022-0663.96.1.43

739 Archibald, L., & Gathercole, S. (2007). Nonword repetition in specific language
740 impairment- More than a phonological short-term memory deficit.
741 *Psychonomic Bulletin & Review*, *14*, 919–924.
742 Asaad, H., & Eviatar, Z. (2013). The effects of orthographic complexity and
743 diglossia on letter naming in Arabic: A developmental study. *Writing Systems*
744 *Research*, *5*(2), 156–168. http://dx.doi.org/10.1080/17586801.2013.862163
745 Asadi, I. A., & Abu-Rabia, S. (2021). The Impact of Diglossia on Phonological
746 Processing. *Reading Psychology*, *42*(7), 685–699.
747 https://doi.org/10.1080/02702711.2020.1864608
748 Asadi, I. A., Khateb, A., Ibrahim, R., & Taha, H. (2017). How do different
749 cognitive and linguistic variables contribute to reading in Arabic? A cross-
750 sectional study from first to sixth grade. *Reading and Writing*, *30*(9), 1835–
751 1867. https://doi.org/10.1007/s11145-017-9755-z
752 Asadi, I. A., Khateb, A., Mansour-Adwan, J., & Khoury-Metanis, A. (2022). When
753 Developmental Language Disorder Meets Diglossia: A Cross-Sectional
754 Investigation of Listening Comprehension Among Native Arabic-Speaking
755 Preschoolers. *Journal of Psycholinguistic Research*.
756 https://doi.org/10.1007/s10936-022-09885-5
757 Ayari, S. (1996). Diglossia and illiteracy in the Arab world [1]. *Language, Culture*
758 *and Curriculum*, *9*(3), 243–253. https://doi.org/10.1080/07908319609525233
759 Bishop, D. V. M., & Snowling, M. J. (2004). Developmental dyslexia and specific
760 language impairment: Same or different? *Psychological Bulletin*, *130*(6),
761 858–886. https://doi.org/10.1037/0033-2909.130.6.858
762 Bishop, Snowling, M. J., Thompson, P. A., Greenhalgh, T., Adams, C., Archibald,
763 L., Baird, G., Bauer, A., Bellair, J., Boyle, C., Brownlie, E., Carter, G., Clark,

764 B., Clegg, J., Cohen, N., Conti-Ramsden, G., Dockrell, J., Dunn, J., Ebbels,
765 S., … Whitehouse, A. (2016). CATALISE: A multinational and
766 multidisciplinary Delphi consensus study. Identifying language impairments
767 in children. *PLoS ONE*, *11*(7), 1–26.
768 https://doi.org/10.1371/journal.pone.0158753
769 Botting, N. (2020). Language, literacy and cognitive skills of young adults with
770 developmental language disorder (DLD). *International Journal of Language*
771 *and Communication Disorders*, *55*(2), 255–265. https://doi.org/10.1111/1460-
772 6984.12518
773 Boudreau, D. M., & Hedberg, N. L. (1999). A Comparison of Early Literacy Skills
774 in Children with Specific Language Impairment and Their Typically
775 Developing Peers. *American Journal of Speech-Language Pathology*, *8*(3),
776 249–260. https://doi.org/10.1044/1058-0360.0803.249
777 Carroll, J. M., Snowling, M. J., Hulme, C., & Stevenson, J. (2003). The
778 Development of Phonological Awareness in Preschool Children.
779 *Developmental Psychology*, *39*(5), 913–923. https://doi.org/10.1037/0012-
780 1649.39.5.913
781 Catts, H. W. (2018). The Simple View of Reading: Advancements and False
782 Impressions. *Remedial and Special Education*, *39*(5), 317–323.
783 https://doi.org/10.1177/0741932518767563
784 Catts, H. W., Herrera, S., Nielsen, D. C., & Bridges, M. S. (2015). Early prediction
785 of reading comprehension within the simple view framework. *Reading and*
786 *Writing*, *28*(9), 1407–1425. https://doi.org/10.1007/s11145-015-9576-x

787 Catts, H. W., & Hogan, T. P. (2003). Language basis of reading disabilities and
788 implications for early identification and remediation. *Reading Psychology*,
789 *24*(3–4), 223–246. https://doi.org/10.1080/02702710390227314
790 Catts, H. W., & Kamhi, A. G. (2005). *The Connections Between Language and*
791 *Reading Disabilities*. Lawrence Erlbaum Associates, Inc., Publishers.
792 Conti-Ramsden, G., & Durkin, K. (2007). Phonological short-term memory,
793 language and literacy: Developmental relationships in early adolescence in
794 young people with SLI. *Journal of Child Psychology and Psychiatry and*
795 *Allied Disciplines*, *48*(2), 147–156. https://doi.org/10.1111/j.1469-
796 7610.2006.01703.x
797 Cunningham, A. J., Burgess, A. P., Witton, C., Talcott, J. B., & Shapiro, L. R.
798 (2020). Dynamic relationships between phonological memory and reading: a
799 five-year longitudinal study from age 4 to 9. *Developmental Science*, 0–2.
800 https://doi.org/10.1111/desc.12986
801 Cunningham, A. J., & Carroll, J. M. (2013). Early predictors of phonological and
802 morphological awareness and the link with reading: Evidence from children
803 with different patterns of early deficit. *Applied Psycholinguistics*, *36*(3), 509–
804 531. https://doi.org/10.1017/S0142716413000295
805 Daniels, P. T. (1992). The syllabic origin of writing and the segmental origin of the
806 alphabet. In *The Linguistics of Literacy* (pp. 83–110).
807 Dawson, N., Rastle, K., & Ricketts, J. (2017). Morphological Effects in Visual
808 Word Recognition: Children, Adolescents, and Adults. *Journal of*
809 *Experimental Psychology: Learning Memory and Cognition*, *44*(4), 645–654.
810 https://doi.org/10.1037/xlm0000485

Dickinson, D. K., Nesbitt, K. T., & Hofer, K. G. (2019). Effects of language on initial reading: Direct and indirect associations between code and language from preschool to first grade. *Early Childhood Research Quarterly*, *49*, 122–137. https://doi.org/10.1016/j.ecresq.2019.04.005

Ehri, L. C. (2017). *Orthographic mapping and literacy development revisited* (pp. 127–146). https://doi.org/10.1075/swll.15.08ehr

Elbeheri, G., & Everatt, J. (2007). Literacy ability and phonological processing skills amongst dyslexic and non-dyslexic speakers of Arabic. *Reading and Writing*, *20*(3), 273–294. https://doi.org/10.1007/s11145-006-9031-0

Foorman, B. R., Herrera, S., Petscher, Y., Mitchell, A., & Truckenmiller, A. (2015). The structure of oral language and reading and their relation to comprehension in Kindergarten through Grade 2. *Reading and Writing*, *28*(5), 655–681. https://doi.org/10.1007/s11145-015-9544-5

Gathercole, S. E., Alloway, T. P., Willis, C., & Adams, A. M. (2006). Working memory in children with reading disabilities. *Journal of Experimental Child Psychology*, *93*(3), 265–281. https://doi.org/10.1016/j.jecp.2005.08.003

Gillon, G. T. (2018). *Phonological Awareness from Research to Practice* (Second). The Guilford Press.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, Reading, and Reading Disability. *Remedial and Special Education*, *7*(1).

Green, L. (2009). Morphology and literacy: Getting our heads in the game. *Language, Speech, and Hearing Services in Schools*, *40*(3), 283–285. https://doi.org/10.1044/0161-1461(2009/08-0091)

Hachmann, W. M., Bogaerts, L., Szmalec, A., Woumans, E., Duyck, W., & Job, R. (2014). Short-term memory for order but not for item information is impaired

836 in developmental dyslexia. *Annals of Dyslexia*, *64*(2), 121–136.
837 https://doi.org/10.1007/s11881-013-0089-5
838 Hassanein, E. E. A., Johnson, E. S., Alshaboul, Y. M., Ibrahim, S. R., & Megreya,
839 A. M. (2021). Examining Factors That Predict Arabic Word Reading in First
840 and Second Graders. *Reading and Writing Quarterly*.
841 https://doi.org/10.1080/10573569.2021.1907637
842 Hermena, E. W., & Reichle, E. D. (2020). Insights from the study of Arabic
843 reading. *Language and Linguistics Compass*, *14*(10), 1–26.
844 https://doi.org/10.1111/lnc3.12400
845 Hipfner-Boucher, K., Milburn, T., Weitzman, E., Greenberg, J., Pelletier, J., &
846 Girolametto, L. (2014). Relationships between preschoolers' oral language
847 and phonological awareness. *First Language*, *34*(2), 178–197.
848 https://doi.org/10.1177/0142723714525945
849 Hoover, W. A., & Tunmer, W. E. (2018). The Simple View of Reading: Three
850 Assessments of Its Adequacy. *Remedial and Special Education*, *39*(5), 304–
851 312. https://doi.org/10.1177/0741932518773154
852 Jackson, E., Leitão, S., Claessen, M., & Boyes, M. (2020). *Working, Declarative,*
853 *and Procedural Memory in Children With Developmental Language*
854 *Disorder*. https://doi.org/10.23641/asha
855 James, E., Currie, N. K., Tong, S. X., & Cain, K. (2020). The relations between
856 morphological awareness and reading comprehension in beginner readers to
857 young adolescents. *Journal of Research in Reading*, 1–21.
858 https://doi.org/10.1111/1467-9817.12316

Justice, L. M. (2006). Evidence-Based Practice, Response to Intervention, and the Prevention of Reading Difficulties. *Language, Speech, and Hearing Services in Schools*, *37*(4), 284–297. https://doi.org/10.1044/0161-1461(2006/033)

Kendeou, P., van den Broek, P., White, M. J., & Lynch, J. S. (2009). Predicting Reading Comprehension in Early Elementary School: The Independent Contributions of Oral Language and Decoding Skills. *Journal of Educational Psychology*, *101*(4), 765–778. https://doi.org/10.1037/a0015956

Layes, S., Lalonde, R., & Rebai, M. (2021). Reading-related abilities underlying phonological awareness: a cross-sectional study in children with and without dyslexia. *Logopedics Phoniatrics Vocology*, *46*(3), 110–117. https://doi.org/10.1080/14015439.2020.1768283

Leonard, L. (2014). *Children with Specific Language Important*. https://doi.org/https://doi.org/10.7551/mitpress/9152. 001.0001

Lonigan, C., Burgess, S., & Anthony, J. (2000). Development of emergent literacy and early reading skills in preschool children: evidence from a latent-variable longitudinal study. *Developmental Psychology*, *36*(5), 596–613. https://doi.org/10.1037/0012-1649.36.5.596

Mansour-Adwan, J., Shalhoub-Awwad, Y., Cohen-Mimran, R., & Khateb, A. (2023). Reading in kindergarten Arabic-speaking children with low linguistic skills: A longitudinal study. *Applied Psycholinguistics*, *44*(2), 265–291. https://doi.org/10.1017/s014271642300019x

Martinez Perez, T., Majerus, S., & Poncelet, M. (2012). The contribution of short-term memory for serial order to early reading acquisition: Evidence from a longitudinal study. *Journal of Experimental Child Psychology*, *111*(4), 708–723. https://doi.org/10.1016/j.jecp.2011.11.007

McBride, C. (2015). *CHILDREN'S LITERACY DEVELOPMENT A Cross-Cultural Perspective on Learning to Read and Write* (2nd ed.). Routledge. www.psypress.com/books/series/DEVP,

McGregor, K. K. (2020). How We Fail Children With Developmental Language Disorder. *Language, Speech, and Hearing Services in Schools*, *51*(4), 981–992. https://doi.org/10.1044/2020_lshss-20-00003

Metsala, J. L., & Walley, A. C. (1998). Spoken Vocabulary Growth and the Segmental Restructuring of Lexical Representations: Precursors to Phonemic Awareness and Early Reading Ability. In *Word recognition in beginning literacy Publisher:* (pp. 99–130). Routledge. http://ebookcentral.proquest.com','_blank'

Montgomery, J. W., Magimairaj, B. M., & Finney, M. C. (2010). Working Memory and Specific Language Impairment: An Update on the Relation and Perspectives on Assessment and Treatment. *American Journal of Speech-Language Pathology*, *19*(1), 78–94. https://doi.org/10.1044/1058-0360(2009/09-0028)

Muter, V., Hulme, C., Snowling, M. J., & Stevenson, J. (2004). Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: Evidence from a longitudinal study. *Developmental Psychology*, *40*(5), 665–681. https://doi.org/10.1037/0012-1649.40.5.665

Nagy, W. E., Carlisle, J. F., & Goodwin, A. P. (2014). Morphological Knowledge and Literacy Acquisition. *Journal of Learning Disabilities*, *47*(1), 3–12. https://doi.org/10.1177/0022219413509967

Nation, K., Cocksey, J., Taylor, J. S. H., & Bishop, D. V. M. (2010). A longitudinal investigation of early reading and language skills in children with

poor reading comprehension. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *51*(9), 1031–1039. https://doi.org/10.1111/j.1469-7610.2010.02254.x

Norbury, C., Gooch, D., Wray, C., Baird, G., Charman, T., Simonoff, E., Vamvakas, G., & Pickles, A. (2016). The impact of nonverbal ability on prevalence and clinical presentation of language disorder: evidence from a population study. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *57*(11), 1247–1257. https://doi.org/10.1111/jcpp.12573

Norbury, C., Tomblin, B. J., & Bishp, D. V. M. (2008). Understanding Developmental Language Disorders. In *Taylor & Francis*.

Pratt, A. S., Grinstead, J. A., & McCauley, R. J. (2020). Emergent literacy in Spanish-speaking children with developmental language disorder: Preliminary findings of delays in comprehension-and code-related skills. *Journal of Speech, Language, and Hearing Research*, *63*(12), 4193–4207. https://doi.org/10.1044/2020_JSLHR-19-00239

Rakhlin, N. V., Li, N., Aljughaiman, A., & Grigorenko, E. L. (2020). Narrative language markers of Arabic language development and impairment. *Journal of Speech, Language, and Hearing Research*, *63*(10), 3472–3487. https://doi.org/10.1044/2020_JSLHR-20-00082

Rhyner, P. M. (2009). *Emergent Literacy and Language Development: Promoting Learning in early childhood*. Guilford Press.

Ricketts, J., Nation, K., & Bishop, D. V. M. (2007). Vocabulary is important for some, but not all reading skills. *Scientific Studies of Reading*, *11*(3), 235–257. https://doi.org/10.1080/10888430701344306

Rowe, M. L. (2018). Understanding Socioeconomic Differences in Parents' Speech to Children. *Child Development Perspectives*, *12*(2), 122–127. https://doi.org/10.1111/cdep.12271

Saiegh-Haddad, E. (2003). Linguistic distance and initial reading acquisition: The case of Arabic diglossia. *Applied Psycholinguistics*, *24*, 431–451.

Saiegh-Haddad, E. (2004). The impact of phonemic and lexical distance on the phonological analysis of words and pseudowords in a diglossic context. *Applied Psycholinguistics*, *25*, 495–512. https://doi.org/10.1017.S0142716404001249

Saiegh-Haddad, E. (2005). Correlates of reading fluency in arabic: Diglossic and orthographic factors. *Reading and Writing*, *18*(6), 559–582. https://doi.org/10.1007/s11145-005-3180-4

Saiegh-Haddad, E. (2007). Linguistic constraints on children's ability to isolate phonemes in Arabic. *Applied Psycholinguistics*, *28*(4), 607–625. https://doi.org/10.1017/S0142716407070336

Saiegh-Haddad, E. (2018). MAWRID: A Model of Arabic Word Reading in Development. *Journal of Learning Disabilities*, *51*(5), 454–462. https://doi.org/10.1177/0022219417720460

Saiegh-Haddad, E. (2022). *A Psycholinguistic-Developmental Approach to the Study of Reading in Arabic Diglossia: Assumptions, Methods, Findings and Educational Implications* (pp. 135–163). https://doi.org/10.1007/978-3-030-80072-7_8

Saiegh-Haddad, E., & Armon-Lotem, S. (2024). Diglossia and developmental language disorder (DLD) in Arabic. The role of linguistic distance and

linguistic proximity. In K. Grohmann (Ed.), *Multifaceted Multilingualism* (Vol. 22, pp. 154–183). John Benjamins.

Saiegh-Haddad, E., & Ghawi-Dakwar, O. (2017). Impact of diglossia on word and non-word repetition among language impaired and typically developing Arabic native speaking children. *Frontiers in Psychology*, *8*(NOV). https://doi.org/10.3389/fpsyg.2017.02010

Saiegh-Haddad, E., Laks, L., & Mcbride, C. (2022). *Handbook of Literacy in Diglossia and in Dialectal Contexts Psycholinguistic, Neurolinguistic, and Educational Perspectives*. https://link.springer.com/bookseries/7206

Saiegh-Haddad, E., & Schiff, R. (2016). The Impact of Diglossia on Voweled and Unvoweled Word Reading in Arabic: A Developmental Study From Childhood to Adolescence. *Scientific Studies of Reading*, *20*(4), 311–324. https://doi.org/10.1080/10888438.2016.1180526

Saiegh-Haddad, E., Shahbari-Kassem, A., & Schiff, R. (2020). Phonological awareness in Arabic: the role of phonological distance, phonological-unit size, and SES. *Reading and Writing*, *33*(6), 1649–1674. https://doi.org/10.1007/s11145-020-10019-3

Scarborough, H. (2001). *Handbook for research in early literacy*. Guilford Press.

Schiff, R., & Saiegh-Haddad, E. (2017). When diglossia meets dyslexia: The effect of diglossia on voweled and unvoweled word reading among native Arabic-speaking dyslexic children. *Reading and Writing*, *30*(5), 1089–1113. https://doi.org/10.1007/s11145-016-9713-1

Schiff, R., & Saiegh-Haddad, E. (2018). Development and relationships between phonological awareness, morphological awareness and word reading in spoken and standard Arabic. *Frontiers in Psychology*, *9*(APR), 1–13.

Seidenberg, M. S. (2005). *Connectionist Models of Word Reading*. *Current directions in psychological science*, 14(5), 238-242.

Shaalan, S. (2017). Reliability and Validity of Four Arabic Language Tests: A comparison of performance of Qatari School-aged children with and without language impairment. In *Arab Journal of Applied Linguistics* 2(1). http://www.arjals.com/

Shaalan, S. (2020). *Nonword Repetition Skills in Gulf Arabic-Speaking Children With Developmental Language Disorder*. https://doi.org/10.23641/asha

Snowling, M. J., Duff, F. J., Nash, H. M., & Hulme, C. (2016). Language profiles and literacy outcomes of children with resolving, emerging, or persisting language impairments. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *57*(12), 1360–1369. https://doi.org/10.1111/jcpp.12497

Snowling, M. J., & Hulme, C. (2013). Children's reading impairments: From theory to practice. *Japanese Psychological Research*, *55*(2), 186–202. https://doi.org/10.1111/j.1468-5884.2012.00541.x

Squires, K. E., Gillam, S. L., & Ray Reutzel, D. (2013). Characteristics of Children Who Struggle with Reading: Teachers and Speech-Language Pathologists Collaborate to Support Young Learners. *Early Childhood Education Journal*, *41*(6), 401–411. https://doi.org/10.1007/s10643-013-0577-6

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: evidence from a longitudinal structural model. *Developmental Psychology*, *38*(6), 934–947.

Suggate, S., Schaughency, E., McAnally, H., & Reese, E. (2018). From infancy to adolescence: The longitudinal links between vocabulary, early literacy skills,

oral narrative, and reading comprehension. *Cognitive Development*, *47*, 82–95. https://doi.org/10.1016/j.cogdev.2018.04.005

Taha, J., Stojanovik, V., & Pagnamenta, E. (2020). Expressive verb morphology deficits in Arabic-speaking children with Developmental Language Disorder. *Speech Language and Hearing Research*, 1–18. https://doi.org/10.1044/2020_JSLHR-19-00292

Taha, J., Stojanovik, V., & Pagnamenta, E. (2021a). *Nonword Repetition Performance of Arabic-Speaking Children With and Without Developmental Language Disorder: A Study on Diagnostic Accuracy*. https://doi.org/10.23641/asha

Taha, J., Stojanovik, V., & Pagnamenta, E. (2021b). Sentence Repetition as a Clinical Marker of Developmental Language Disorder: Evidence From Arabic. *Journal of Speech, Language, and Hearing Research*, *64*(12), 4876–4899. https://doi.org/10.1044/2021_jslhr-21-00244

Tambyraja, S. R., Schmitt, M. B., Farquharson, K., & Justice, L. M. (2015). *Person-centered approach to examining emergent literacy risks in children with specific language impairment* (Vol. 5).

Thatcher, K. L. (2010). The development of phonological awareness with specific language-impaired and typical children. *Psychology in the Schools*, *47*(5), 467–480. https://doi.org/10.1002/pits.20483

Ullman, M. T., Earle, F. S., Walenski, M., & Janacsek, K. (2020). The neurocognition of developmental disorders of language. *Annual Review of Psychology*, *71*, 389–417. https://doi.org/10.1146/ANNUREV-PSYCH-122216-011555

Ventura, P., Kolinsky, R., Fernandes, S., Querido, L., & Morais, J. (2007). Lexical restructuring in the absence of literacy. *Cognition*, *105*(2), 334–361. https://doi.org/10.1016/j.cognition.2006.10.002

Wolf, M. C., Muijselaar, M. M. L., Boonstra, A. M., & de Bree, E. H. (2019). The relationship between reading and listening comprehension: shared and modality-specific components. *Reading and Writing*, *32*(7), 1747–1767. https://doi.org/10.1007/s11145-018-9924-8

Zayed, A. M., Roehrig, A. D., Arrastia-Lloyd, M. C., & Gilgil, N. M. (2013). Phonological Awareness and Working Memory in Arabic-Speaking Egyptian Preschool Children at Risk for Dyslexia. *International Journal of Psychological Studies*, *5*(1). https://doi.org/10.5539/ijps.v5n1p139