Predictors of Chinese reading in Chinese monolingual and Chinese–English bilingual children in Mainland China

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Abstract

There is a growing number of children learning to read in bilingual environments, yet research on the uniqueness of reading acquisition in these bilingual children, particularly L1 majority bilinguals, is limited. With a sample size of 690 4th-grade students, this study investigated predictors influencing L1 Chinese reading in Chinese–English bilingual children (n = 345) attending Chinese–English bilingual schools in mainland China and made comparisons with their monolingual counterparts (n = 345). The results of a multi-group path analysis revealed both similarities and differences between the two groups. In terms of Chinese reading comprehension, word reading and linguistic comprehension were significant predictors for both groups, but their relative importance differed. While there was no difference in the predictive power between the two predictors in the monolingual group, word reading held a greater contribution in the bilingual group. Regarding Chinese word reading, both morphological and orthographic awareness emerged as significant predictors in the monolingual group, whereas in the bilingual group, only morphological awareness was significant, and the contribution of phonological awareness was insignificant in either group. These findings underscore the distinct relationship between reading and its predictive constituents in bilingual students when compared to their monolingual counterparts.

Keywords Bilingual · Reading comprehension · Word reading · Linguistic comprehension · Metalinguistic awareness

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Introduction

The acquisition of reading skills is crucial for children's academic achievement (Cimmiyotti, 2013) and future development (OECD, 2013). Extensive research has explored factors influencing reading development, primarily focusing on monolingual children (Ruddell & Unrau, 2004). However, it is crucial to recognize the growing population of bilinguals who are learning to read in diverse bilingual contexts (August & Shanahan, 2008).

Defining bilingualism is essential before examining this issue. However, there is no universal standard for a strict definition, nor is there a clear-cut delineation to separate bilinguals from monolinguals categorically. Many scholars (Ellis, 2008; Luk & Bialystok, 2013; Surrain & Luk, 2019) have highlighted monolingualism and bilingualism are relative and should be perceived as existing on a continuum of language proficiency and usage. Based on the distinctions made in earlier research (Jasińska & Petitto, 2018; Kang, 2012; Sun et al., 2020), this study operationally defines bilinguals as individuals who have access to and regularly use more than one language for social communication, highlighting their proficiency and opportunity to use a second language (L2) besides their first language (L1). Among bilinguals, there are L1 minority bilinguals who live in societies where their L1 is a minority and must learn and use a L2 for survival. Conversely, there are L1 majority bilinguals who reside in societies where their L1 is the majority but opt to learn and use a L2 in an immersion environment to gain the benefits of bilingualism. In contrast, monolinguals, even though some may study L2, typically lack proficiency and opportunities to use that language for social communication. These differential language experiences can influence the development of monolinguals' and bilinguals' reading componential skills, ultimately resulting in distinct patterns of reading acquisition (Bialystok, 2002).

In mainland China, mandarin is the lingua franca and the only official language for administration and education. Most children are Chinese monolinguals, who despite learning English, often lack proficiency and opportunities to use English regularly. However, since around 2015, the rise of high-end Chinese–English bilingual education has led to an increase in L1 majority bilinguals in mainland China (Newschool Insight Media, 2019). These schools, catering to affluent local families seeking bilingualism and international competitiveness for their children (Wan & Gao, 2021), hire English-native-speaking teachers to deliver a certain proportion of non-language courses in English. Students in these schools are Chinese–English bilinguals in a sense that they are immersed in bilingual school environments, engaging in daily learning activities that necessitate the use of both Chinese and English in conversational and academic contexts. In practice, these bilingual students are required to attain equivalent Chinese reading goals as their monolingual counterparts with identical Chinese learning materials and instruction time. However, concerns have been raised by parents and educators regarding the perceived inadequate Chinese reading abilities of these children (Wan & Gao, 2021). And this raises important questions about whether these children's

Chinese reading acquisition patterns align with those of monolingual peers and whether they should be treated equivalently.

To our knowledge, no studies have systematically examined the uniqueness of Chinese reading acquisition among these Chinese–English bilinguals in mainland China by comparing them with Chinese monolinguals thus far. Previous research has predominantly focused on L1 minority bilinguals (Babayigit, 2014; Melby-Lervåg & Lervåg, 2014), with few studies addressing the uniqueness of L1 majority bilinguals learning to read their L1 (Jasińska & Petitto, 2018; Kang, 2012). Also, majority of these studies involving bilinguals learning two alphabetic scripts. However, learning to read different scripts requires different language-dependent skills (Abu-Rabia, 2001; Geva & Siegel, 2000), and the linguistic distance can also affect the cross-linguistic transfer when learning to read both scripts (Koda, 2007). Thus, findings from past research cannot be directly applied to L1 majority bilinguals in mainland China, who are learning Chinese as a non-alphabetic script and English as an opaque alphabetic script. This study endeavors to bridge this gap by examining Chinese reading and its predictors among these Chinese–English bilinguals and comparing with their monolingual counterparts. By doing so, we aim to inform the development of tailored reading curricula and instructions for this specific bilingual population and to enhance our understanding of how diverse bilingual experiences and language combinations may impact bilinguals' reading development.

Predictors of Chinese reading in monolingual children

Reading is a complex cognitive process in which readers engage with the text to construct meanings (Dijk& Kintsch, 1983). The Simple View of Reading (Gough & Tunmer, 1986) posits that reading comprehension shares many cognitive processing capabilities with general linguistic comprehension and differs only in the input material format. In other words, once readers have decoded the visual symbols, they can apply linguistic comprehension mechanisms to understand the text. Hence, word reading, which refers to the ability to recognize isolated words with accuracy and fluency, and linguistic comprehension, which involves interpreting meaning in words, sentences, and discourses, are considered the two proximal predictors of reading comprehension. Empirical research on native and foreign-language learners across scripts and learning stages has consistently supported that word reading and linguistic comprehension each make distinctive contributions to reading comprehension, while also found that they are significantly interconnected (Florit & Cain, 2011; Quinn & Wagner, 2018). Their interconnection may be partly explained by the linking role of vocabulary between word reading and linguistic comprehension (Protopapas et al., 2013). Vocabulary can both aid word reading by providing semantic cues according to the triangle model (Seidenberg & McClelland, 1989) and facilitate meaning retrieval at the word level, which then enhances linguistic comprehension at higher levels. However, further studies using latent analysis have found that vocabulary and listening comprehension are both loaded onto linguistic comprehension (Braze et al., 2016; Protopapas et al., 2013). This places vocabulary as a subcomponent of linguistic comprehension that also enhances word reading,

thereby explaining their correlation. In the context of Chinese reading comprehension, empirical studies have supported that these two interrelated predictors can mutually contribute to Chinese reading comprehension both concurrently and longitudinally (Ho et al., 2017; Yeung et al., 2016).

Moreover, the relative importance of word reading and linguistic comprehension varies across reading development stages (Florit & Cain, 2011; García & Cain, 2014; Peng et al., 2021). Typically, word reading contributes more in the initial stages of learning to read. As students become proficient in word reading, the influence of linguistic comprehension grows more pronounced. Achieving proficiency in word reading is thus a critical initial hurdle that must be overcome for subsequent reading development to occur. This dynamic is particularly pronounced in learning to read Chinese due to the script features. Chinese characters, being the fundamental units, present visual complexity and exist in vast numbers, making the acquisition of Chinese word reading both challenging and time-consuming. Consequently, word reading remains a focal point of instruction throughout elementary education in mainland China (Ministry of Education, 2022). The importance placed on Chinese word reading has further sparked extensive research into its predictors.

Metalinguistic awareness, the ability to reflect on and manipulate language structural features deliberately and intentionally, is recognized as a key influence on word reading acquisition (Nagy & Anderson, 1995). The proficiency in identifying and utilizing linguistic components of spoken language aids in comprehending the connection between speech and written text, which is crucial for literacy development (Perfetti, 2003). Extensive research has shown that learners' awareness of phonological structure, morphological structure, and orthographic patterns, namely phonological, morphological, and orthographic awareness, respectively, significantly correlates with their reading and spelling abilities in both alphabetic (Apel et al., 2012) and non-alphabetic scripts (Li et al., 2012; Ye et al., 2022). In fact, some new reading models (e.g., Active Model, Duke & Cartwright, 2021) have incorporated metalinguistic awareness as a critical constituent when unpacking word reading.

In Chinese, a morpho-syllabic script, the role of all three metalinguistic skills in word reading has been underlined by many studies. First, phonological awareness is crucial for Chinese word reading, as supported by empirical studies (e.g., Chow et al., 2005) in line with the universal phonological principle (Perfetti et al., 1992) that phonological processes play a universal role in word identification across scripts. Second, orthographic awareness is essential in learning Chinese characters (Peng et al., 2017). The visual structure of Chinese character is complex, requiring strong abilities to process their form properties and discern subtle differences during Chinese word reading (Liu et al., 2015). Also, as most characters (80.5%) are compounds (e.g., 苹,/pʰˈɪŋ³⁵, malus/) composed of phonetic radicals cuing sounds (平/pʰˈɪŋ³⁵/) and semantic radicals cuing meaning (艹/indicating herbaceous plant/) (Li et al., 1992), understanding the functions of these radicals facilitates Chinese character learning (Cheung et al., 2007). Third, morphological awareness can also facilitate Chinese word reading (Liao et al., 2014; McBride-Chang et al., 2005). Most Chinese words are compounds formed by morphemes following combination rules. Chinese morphological awareness primarily involves the ability to distinguish between a multitude of homophonic morphemes (e.g., 艺/art/and 亿/hundred

million/are pronounced identically as/i^4/but have completely different meanings) and the knowledge of the combination rules for compound formation (e.g., 地震/ti^{51} $tʂən^{51}$, earthquake/was combined by 地/ti^{51}, earth/and 震/$tʂən^{51}$, shake/following subject–predicate rule). It promotes vocabulary learning and the retrieval of word-internal context, which in turn enhances Chinese word reading development (Liu et al., 2017; Wang & Liu, 2020).

Integrating metalinguistic awareness into Simple View of Reading as a predictor of word reading may boost statistical power (Peng et al., 2021), but it is crucial to consider its potential interrelation with linguistic comprehension. On the one hand, scholars (Bialystok, 1993; Marshall & Morton, 1978) have argued that metalinguistic awareness develops concomitantly with the oral language skills, supported by empirical studies (e.g., Farrar et al., 2005; Smith & Tager-Flusberg, 1982) showing a bidirectional correlation between metalinguistic awareness and general language abilities. On the other hand, metalinguistic awareness can influence linguistic comprehension at and beyond the word level. The Reading Systems Framework suggests that phonological and morphological representations are crucial sources for lexicon and comprehension processes (Perfetti & Stafura, 2014). Also, given the ideographic nature of Chinese script, semantic radicals as sub-character level meaning representations can aid in lexical inference (Wong et al., 2023; Zhang et al., 2012) and vocabulary learning (Li et al., 2022), which allows for an interrelation between orthographic awareness and linguistic comprehension.

In summary, as depicted in Fig. 1, word reading and linguistic comprehension are mutually related and both predict Chinese reading comprehension. Metalinguistic awareness, encompassing phonological, orthographic, and morphological awareness, are associated with linguistic comprehension and further predict Chinese word reading. Extensive research has validated their interrelationships in monolinguals
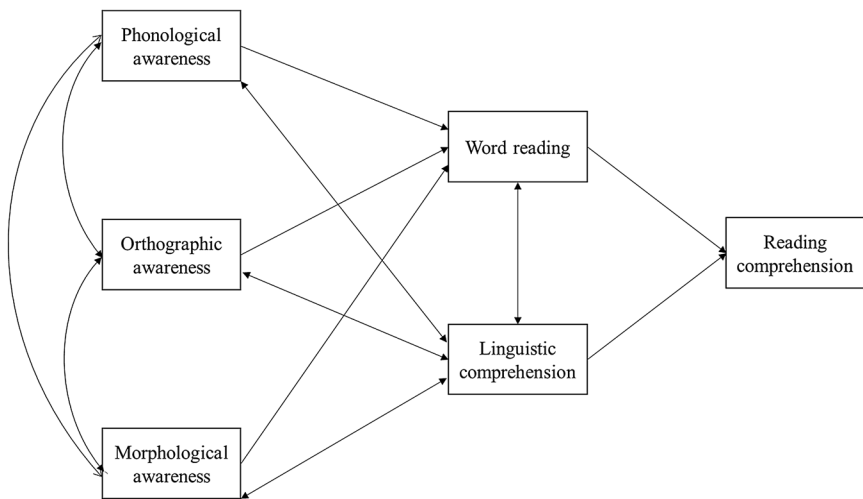
The Proposed Model to Explain Chinese Reading

Fig. 1 The proposed model to explain Chinese reading

and the effectiveness of this model in explaining individual differences in Chinese reading (see review, Peng et al., 2021). However, whether these predictors exhibit similar patterns in predicting Chinese reading among Chinese–English bilingual learners warrants further exploration.

Unique predictor patterns of bilingual children's reading

The bilingual experience of bilingual children can influence the development of reading predictors, resulting in different reading acquisition patterns from monolinguals (August & Shanahan, 2008; Bialystok, 2002). Many empirical studies have explored the L2 reading acquisition of L1 minority bilinguals and consistently found a stronger correlation between linguistic comprehension and reading comprehension among them compared to monolinguals (Babayigit, 2014; Papastefanou et al., 2021), suggesting that weaker linguistic comprehension is a primary factor behind their lower L2 reading comprehension (Lesaux et al., 2006; Melby-Lervåg & Lervåg, 2014).

In contrast, research on the uniqueness of L1 majority bilinguals learning to read their L1 in bilingual contexts is notably sparse. Jasińska and Petitto (2018) conducted a comparative study between English (L1) monolinguals and English (L1)-French (L2) bilinguals in Canada. They found that phonological awareness and linguistic comprehension significantly predicted English word reading in monolinguals, while for bilinguals, only phonological awareness remained a significant predictor. They suggested that bilinguals may leverage their phonological awareness advantage when learning to read English words. Novita et al. (2021) examined the differences in L1 German reading acquisition between monolinguals and L1 majority bilinguals exposed to another language, finding that although bilinguals lagged behind in linguistic comprehension, the predictive power of phonological awareness and linguistic comprehension on German reading comprehension was comparable across both groups. The absence of a clear consensus on whether monolingual and L1 majority bilingual children exhibit more similarities or differences in their L1 reading predictor profiles underscores the need for further investigation.

In addition, most of the research conducted in this area has focused on bilinguals learning two alphabetic scripts. However, Chinese–English bilinguals face unique challenges as they simultaneously learn to read Chinese as a non-alphabetic script and English as an alphabetic script, both with relatively opaque orthographies and considerable linguistic distance. The Common Underlying Proficiency model (Cummins, 1980) and the Transfer Facilitation Model (Koda, 2007) suggest that learning one language can enhance the learning of another through cross-linguistic transfer. However, this facilitative relationship is moderated by linguistic distance (Koda, 2007). The significant differences between Chinese and English may inhibit Chinese–English bilinguals' reading development to benefit from cross-linguistic facilitation. Many studies have examined this issue among Chinese–English bilinguals. They found positive transfers in areas where Chinese and English share similarities, such as phonological and morphological awareness (Yang et al., 2017). However, in areas with greater linguistic disparity, such as vocabulary and orthographic

awareness, the transfer effects are weaker or even negligible (Sun et al., 2018; Yang et al., 2017). However, despite these attempts to explore the interplay between learning Chinese and English, there is still limited understanding of what uniqueness in Chinese–English bilingual children's Chinese reading has been resulted from these intertwining cross-linguistic influences.

Indeed, Chinese–English bilingual learners can demonstrate differences in their levels of Chinese reading and its predictors compared to their monolingual peers (Bialystok et al., 2005; Lin & Johnson, 2016; Tse et al., 2010), which consequently may lead to variations in the relationships among these skills. For instance, Sun et al. (2020) compared Chinese monolinguals in Mainland China and Chinese–English bilinguals in Singapore and found that morphological awareness was a unique predictor of Chinese reading comprehension exclusively in bilinguals after controlling for other linguistic comprehension skills (i.e., vocabulary and grammar). The researchers postulated that this discrepancy might be attributed to the potential delays in Chinese word reading among bilinguals, leading to a greater reliance on morphological awareness during the Chinese reading process. Nevertheless, the current body of research on the distinct predictor profiles influencing Chinese reading in Chinese–English bilingual learners compared to Chinese monolinguals is indeed limited, and there is no consensus thus far, warranting further studies to deepen our understanding in this area.

The present study

In summary, understanding the cognitive predictors that influence individual differences in reading is crucial. However, current research on Chinese reading has primarily focused on Chinese monolingual children, leaving a gap in understanding how these factors operate differently in Chinese reading in the growing population of Chinese–English bilingual children. To address this gap, this study aims to examine predictors that explain Chinese reading in Chinese–English bilingual learners, comparing them to their monolingual peers. Drawing upon relevant reading models and previous empirical research, the proposed model with five predictors, as illustrated in Fig. 1, are used to elucidate the variations in students' Chinese reading. Specifically, the research questions include:

(1) What is the predictive significance and relative importance of word reading and linguistic comprehension in predicting Chinese reading comprehension for Chinese monolinguals and Chinese–English bilinguals, respectively?

Prior literature leads us to hypothesize that both word reading and linguistic comprehension significantly predict Chinese reading comprehension. However, for monolinguals, the contribution of word reading may diminish after the second grade (Peng et al., 2021), suggesting that by the fourth grade, as in our study sample, it may not be more important than linguistic comprehension. For bilinguals, due to the lack of research specific to this group, it is uncertain whether their word reading has

developed to a sufficient level, and therefore, the relative importance of these predictors remains undetermined.

(2) What is the predictive significance and relative importance of phonological, orthographic, and morphological awareness in predicting Chinese word reading for Chinese monolinguals and Chinese–English bilinguals, respectively?

For monolinguals, previous literature (Li et al., 2012; McBride et al., 2005) suggests that orthographic and morphological awareness are likely to contribute uniquely and significantly to Chinese word reading, whereas phonological awareness may not provide a unique contribution for upper primary graders. However, the relative importance of these metalinguistic skills has not been definitively compared in the existing literature, leaving their predictive hierarchy uncertain. For bilinguals, patterns of contribution from these metalinguistic skills are expected to vary due to cross-linguistic transfer effects. Yet, the specific nature of these differences remains unclear due to limited research on these populations.

Method

Participants

Chinese–English bilingual participants were recruited from four high-end Chinese–English bilingual schools in four economically developed cities in the eastern coastal region of mainland China. In these schools, students were immersed in a bilingual environment with classroom and campus settings featuring both Chinese and English from the first grade onward. Beside of English-medium non-language courses, English language lessons in these schools were also delivered by English native-speaking teachers and comprised an equivalent or even greater share of instructional time compared to Chinese language courses. By the upper primary grades, students in these schools possess the proficiency and need to engage daily in conversations with teachers and classmates using both Chinese and English as well as to read and write in both languages to complete academic tasks.

Four monolingual schools were also recruited for comparison purposes. They demonstrated comparability with bilingual participating schools in the following aspects. Firstly, they were recruited from the same cities as the bilingual schools. Secondly, as primary school falls under the compulsory education stage, both types of schools must adhere to the national curriculum guidelines for the majority of their courses. The textbooks, instruction time, and requirements for their Chinese language courses are in line with the same standard. Thirdly, monolingual schools affiliated with universities in the respective cities were selected to maximize the alignment of the rich teaching resources and students' middle to high socioeconomic backgrounds in bilingual schools. In these monolingual schools, instruction is exclusively in Chinese, with English only taught as a foreign language by non-native-English-speaking local teachers. The teaching of English is conducted in line

with the national curriculum standards, with much less instructional time allotted to English than to Chinese language classes. Within the four participating monolingual schools, three begin offering English lessons two to three times weekly starting from grade 1, while the fourth school start English course thrice-weekly from grade 3. Adhering to the national curriculum standards, students in grades 3 and 4 are introduced only to fundamental English knowledge and skills, such as greetings and self-introductions. Their English proficiency is limited to basic vocabulary and sentences outlined in the textbooks. Hence, participants in these monolingual schools are considered Chinese monolinguals in a sense that they lack proficiency and opportunities to use English for social communication.

Fourth-grade students in the selected schools were recruited. This grade level was deemed appropriate as these students had experienced years of bilingual or monolingual learning environments, allowing them to better represent the circumstances of bilingual and monolingual individuals. Additionally, they are in the critical transition stage according to the reading developmental stages (Chall, 1996) and are more indicative of the outcomes of learning to read and readiness to read to learn. Besides, only students who are exclusively Chinese native-speakers participated in this study.

Finally, a total of 690 students participated in this study. Half of them ($n = 345$) were Chinese–English bilinguals, comprising 198 males (57.4%) and 147 females (42.6%), with an average age of 9.84 years ($SD = 0.34$). The other half ($n = 345$) were Chinese monolinguals, consisting of 178 males (51.6%) and 167 females (48.4%), with an average age of 9.81 years ($SD = 0.40$). No significant differences were observed between the two groups in terms of age ($t(688) = 0.791$, $p = 0.429$) and the gender distribution ($\chi^2(1) = 2.338$, $p = 0.126$).

Measures

Reading comprehension

The reading comprehension test was adapted from Progress in International Reading Literacy Study (PIRLS). PIRLS was intentionally designed to assess the reading achievement of primary four students worldwide (Mullis & Martin, 2019) and has been used to measure Chinese reading attainment of students in Hong Kong, Taiwan, and Macao. For this study, a fiction text, "The Upside-down Mice" from PIRLS 2001, and a non-fiction text "The Green Sea Turtle's Journey of a Lifetime" from PIRLS 2016, were selected. Participants were asked to read these texts and answer 24 questions, including both closed and open-ended questions, measuring the ability to access and retrieve explicitly stated information, make inferences, interpret and synthesize information, and evaluate text's content and form.

Word reading

With reference to previous studies (Liu & McBride-Chang, 2010), the word reading test consisting of 75 single-character items and 25 two-character word items

was developed. To form the word reading list, the official Chinese textbooks that were used nationwide in both Chinese monolingual and Chinese–English bilingual schools were referred to. Fifteen single characters and 5 two-character words were randomly selected from the new character tables attached to the Chinese textbooks for each grade from grade 1–5 and were ranked according to increasing difficulty. Participants were asked to read aloud characters in order without time limitation. One mark was given for the correct pronunciation of that characters.

Linguistic comprehension

The linguistic comprehension test was developed with two sections. First, the receptive vocabulary section, with 20 items, was developed with reference to the Peabody Picture Vocabulary Test (PPVT, Williams et al., 1997) to tap participants' linguistic comprehension ability at the word level. Participants were required to select an option from 4 pictures that best matched the meaning of the word they heard from the audio. Second, the listening comprehension section, with 18 items, were adapted from Hong Kong Examinations and Assessment Authority (2021) to tap participants' linguistic comprehension skill at the sentence and discourse level. As mainland China lacks standardized Chinese listening tests designed for native speakers, the test from the Hong Kong Territory-wide System Assessment, which is a standardized test local to Hong Kong, was referenced. This test offers versions in Mandarin and Simplified Chinese characters, and its content was not restricted by Hong Kong-specific contexts and culture, making it suitable for mainland students. After consultation with mainland teachers, the difficulty level of the Primary 6 assessment was deemed appropriate for our participants. In this section, participants were required to answer both closed and open-ended questions based on the listening materials.

Phonological awareness

With reference to Wong and Zhou (2022), a discrimination task with 12 items was used to tap participants' phonological awareness. Participants were required to choose the syllable that has no similarities with the other three syllables in either initial, final, or tone. For example, among the four options of /pa^1/(巴, a family name), /pa^2/(拔, to pull out), /pha^4/(怕, to fear), /pa^3/(把, hold),/pha^4/ is the correct answer since it has a different initial consonant compared to other options. One point was given for each correct answer.

Orthographic awareness

The orthographic awareness test was developed with reference to Tong et al. (2017) to assess participants' orthographic awareness, including the form awareness and semantic radicals' function awareness. The test consisted of 12 items. In each item, an oral-presented instruction and a picture were given to indicate the target character's meaning, and participants were required to take advantage of their orthographic awareness to select, from the four options, the target character that best matched the

meaning. To make sure that all target characters were novel to participants, those only existing in ancient prints and no longer used today were chosen. Besides the correct answer, three distractor options were designed to include a pseudo character with the same semantic radical as the target character but in the wrong position, a pseudo or real character with the different semantic radical as the target character in the correct position, and a pseudo character with the different semantic radical as target character in the wrong position. Students were scored 2 points if they select the target Chinese character correctly. If the selected option contains the correct semantic radical but is positioned incorrectly, or if it is positioned correctly but does not correspond to the target semantic radical, students receive 1 point. Otherwise, no points were given.

Morphological awareness

With reference to Wong and Zhou (2022), the morphological awareness test with 15 items was designed to assess participants' awareness of homophones and homographs. Each item presented three two-character words that shared a homophone or homograph relationship (e.g., 花费/'hwa¹feɪ⁴, cost/, 花园/'hwa¹iʊan², garden/, 花盆/'hwa¹pən², flowerpot/). Participants were required to select the option that had a different meaning from the others (in this case, 花费). One point was given for each correct answer.

Procedure

Before collecting data, consent was secured from school principals, teachers, and guardians of the participants. The tests were administered under the supervision of Chinese language teachers in the school classrooms to ensure that participants worked independently and seriously. The word reading task was conducted individually at a separate time, in a quiet classroom, and by trained Chinese teachers and researchers, taking approximately 3 min per student. The remaining written tasks were conducted in a group test format and lasted 75 min in total. To prevent participant fatigue, the test was divided into two 40 min periods with an intervening break.

Data analysis

Data analysis was conducted in SPSS 23.0 and AMOS 23.0. First, the internal consistency of all measures was assessed to ensure reliability. Second, descriptive statistics were computed to provide an overview of the participants' performance. Furthermore, ANCOVA tests were performed to compare performance between the two groups while controlling for age and gender. Third, a multi-group path analysis was conducted to examine the patterns of predictors for Chinese reading among the two groups while controlling for age and gender. On the one hand, we examined whether the significant predictors for Chinese reading were consistent across groups. On the other hand, to address whether the relative importance of these predictors differed between groups, we conducted constrained models by placing equality constraints to

the paths being compared. A significant deterioration in fit compared to the unconstrained model indicated a significant difference in the relative importance of the paths.

Results

Descriptive analysis

The descriptive statistics for all variables are presented in Table 1. All measures demonstrated satisfactory internal consistency with Cronbach's alpha coefficients ranging from 0.62 to 0.96 (Cooper & Schindler, 2003). The ANCOVA tests revealed that monolinguals outperformed bilinguals in Chinese reading comprehension (F (1, 686)=47.80, $p < 0.001$) in a medium effect size ($\eta_p^2 = 0.07$), linguistic comprehension (F (1, 686)=43.09, $p < 0.001$) in a small effect size ($\eta_p^2 = 0.06$), word reading (F (1, 686)=152.34, $p < 0.001$) in a large effect size ($\eta_p^2 = 0.18$), and orthographic awareness (F (1, 686)=24.02, $p < 0.001$) in a small effect size ($\eta_p^2 = 0.03$). However, the two groups did not differ in phonological (F (1, 686)=1.27, $p = 0.26$) and morphological awareness (F (1, 686)=0.35, $p = 0.55$).

Multi-group path analysis

Correlations among all variables are displayed in Table 2. A multi-group path analysis was conducted to examine predictor patterns in monolingual and bilingual groups while controlling for age and gender. The results indicated an acceptable goodness of fit, χ^2 (8)=20.64, $p = 0.008$, CFI=0.99, SRMR=0.03, RMSEA=0.05, 90% CI [0.02, 0.07], PCLOSE=0.51.

For monolinguals, as depicted in Fig. 2, both word reading ($\beta = 0.34$; $p < 0.001$) and linguistic comprehension ($\beta = 0.35$; $p < 0.001$) significantly predicted Chinese reading comprehension. To compare the relative importance of word reading and linguistic comprehension, a constrained model was established by constraining their paths to reading comprehension to be equal. The results showed that compared to the unconstrained model, the fit of the constrained model did not significantly change, $\Delta \chi^2$ (1)=1.46, $p = 0.23$, indicating that the contributions of word reading and linguistic comprehension to reading comprehension did not differ significantly in monolinguals. Furthermore, among the three aspects of metalinguistic awareness, while orthographic awareness ($\beta = 0.17$; $p = 0.001$) and morphological awareness ($\beta = 0.23$; $p < 0.001$) significantly contributed to Chinese word reading, phonological awareness did not contribute significantly ($p = 0.09$). A constrained model was examined by constraining the paths of these three metalinguistic skills to word reading to be equal. The results showed that compared to the unconstrained model, the fit of the constrained model did not significantly change, $\Delta \chi^2$ (2)=2.42, $p = 0.30$, indicating that the contributions of these three metalinguistic skills to word reading did not differ significantly. This model explained 34% of the variance in Chinese reading comprehension and 14% in Chinese word reading among monolinguals.

Table 1 Descriptive Statistics for All the Variables and Comparisons between Bilingual and Monolingual Participants

Variable	Cronbach's Alpha	Maximum Score	Monolinguals (N = 345)				Bilinguals (N = 345)				F	η_p^2
			Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis		
RC	.78	32	20.73	4.44	−.53	.33	18.10	5.56	-.62	-.04	47.80***	.07
LC	.84	38	25.56	5.18	− 1.13	1.23	22.66	6.57	-.83	.01	43.09***	.06
WR	.96	125	115.84	6.74	− .96	.64	104.53	15.60	-1.62	2.87	152.343***	.18
PA	.77	12	7.73	2.84	− 1.08	.83	7.51	2.97	-.90	.18	1.27	.00
OA	.62	24	21.21	2.27	− 1.46	3.37	20.34	2.61	-1.46	3.13	24.02***	.03
MA	.78	15	8.09	3.37	− .14	-.79	7.95	3.22	-.26	-.41	.35	.00

RC = Reading Comprehension; LC = Linguistic Comprehension; WR = Word Reading; PA = Phonological Awareness; OA = Orthographic Awareness; MA = Morphological Awareness

*p < .05, **p < .01, ***p < .001

Table 2 Simple correlations between all the variables in bilingual and monolingual participants

	1	2	3	4	5	6	7	8
1. Age	1	−.08	.00	.06	.03	−.00	.07	−.03
2. Gender (0=Male)	.05	1	.07	.13*	.10	.09	.19**	.03
3. RC	.11*	.06	1	.49**	.49**	.24**	.29**	.31**
4. LC	.00	.07	.59**	1	.43**	.28**	.27**	.31**
5. WR	−.03	−.02	.63**	.57**	1	.20**	.26**	.30**
6. PA	.10	.13*	.23**	.26**	.14**	1	.23**	.29**
7. OA	.03	.10	.18**	.23**	.10	.22**	1	.24**
8. MA	−.03	−.02	.26**	.35**	.27**	.18**	.05	1

Simple correlations for the bilingual group were presented below the diagonal, and simple correlations for the monolingual group were presented above the diagonal. RC=Reading Comprehension; LC=Linguistic Comprehension; WR=Word Reading; PA=Phonological Awareness; OA=Orthographic Awareness; MA=Morphological Awareness

$*p<.05$, $**p<.01$, $***p<.001$

Path Model Representing Relationships between Chinese Reading and its Predictors in Monolinguals
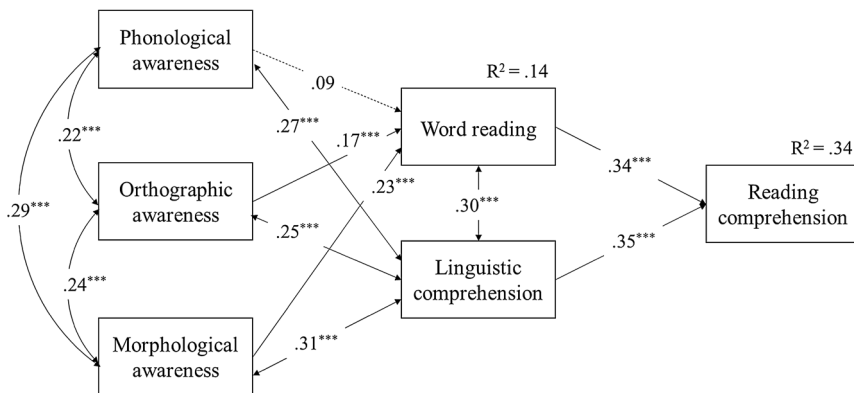
Fig. 2 Path model representing relationships between Chinese reading and its predictors in Monolinguals. The solid lines represent significant paths, while the dashed lines represent insignificant paths. $*p<.05$, $**p<.01$, $***p<.001$

For bilinguals, as illustrated in Fig. 3, both word reading ($\beta=0.45$; $p<0.001$) and linguistic comprehension ($\beta=0.33$; $p<0.001$) demonstrated significant predictive power for Chinese reading comprehension. Furthermore, the model constraining paths from word reading and linguistic comprehension to reading comprehension to be equal exhibited a significant deterioration compared to the unconstrained model, $\Delta\chi^2(1)=5.49$, $p=0.02$, suggesting that word reading held a greater importance for reading comprehension in bilinguals. Additionally, among the three aspects of meta-linguistic awareness, only morphological awareness ($\beta=0.25$; $p<0.001$) exhibited

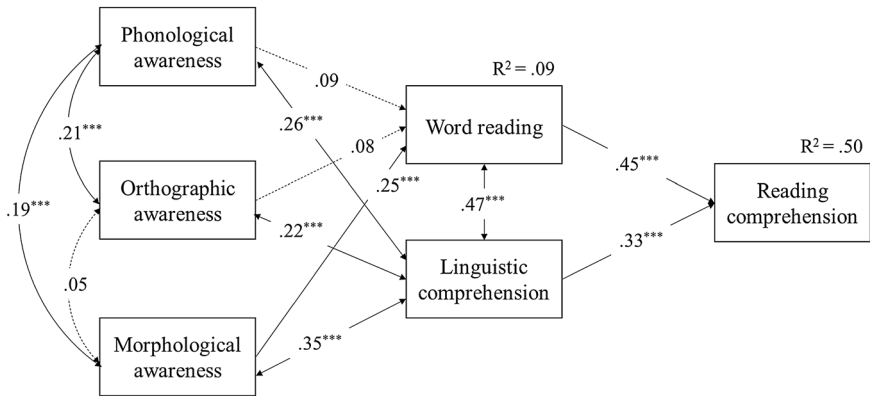*Path Model Representing Relationships between Chinese Reading and its Predictors in Bilinguals*

Fig. 3 Path model representing relationships between Chinese reading and its predictors in bilinguals. The solid lines represent significant paths, while the dashed lines represent insignificant paths. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

a significant effect on Chinese word reading, while both phonological ($\beta = 0.09$; $p = 0.11$) and orthographic awareness ($\beta = 0.08$; $p = 0.15$) did not. The constrained model, with equal paths from the three metalinguistic skills to word reading, showed no significant fit change from the unconstrained model, $\Delta \chi^2$ (2) $= 4.57$, $p = 0.10$, indicating no significant differences in the contributions of these three metalinguistic skills to word reading. Notably, in contrast to monolinguals where orthographic and morphological awareness were significantly correlated ($\beta = 0.24$; $p < 0.001$), no significant correlation was observed between these two variables in bilinguals ($\beta = 0.05$; $p = 0.38$). This model accounted for 50% of the variance in Chinese reading comprehension and 9% in Chinese word reading among bilinguals.

Discussion

This study explored predictors of Chinese reading in Chinese monolingual and Chinese–English bilingual students in mainland China. The findings uncovered both similarities and distinctions in the observed patterns. Word reading and linguistic comprehension were significant predictors of Chinese reading comprehension in both groups. However, while word reading held equal importance as linguistic comprehension for monolinguals, it was more critical for bilinguals. Additionally, phonological awareness had no unique impact on Chinese word reading, whereas morphological awareness was vital for both groups. Interestingly, orthographic awareness proved to be a unique predictor for monolinguals but not bilinguals.

First, this study confirmed that word reading and linguistic comprehension significantly predicted Chinese reading comprehension for both monolinguals and bilinguals, while their relative importance varied between the groups. For monolingual fourth-graders in this study, both predictors held similar importance, aligning with

our hypothesis and the second-grade turning point identified by Peng et al. (2021). As these students have progressed in word reading, their word reading is not more important than linguistic comprehension.

However, for bilinguals, word reading held greater importance than linguistic comprehension, which could be attributed to their even weaker word reading skills. The bilinguals in this study only showed a small effect size for linguistic comprehension deficiency. The dispersed distribution of lexical knowledge in bilinguals may limit their access to all language domains, potentially leading to diminished linguistic proficiency, particularly in vocabulary (Bialystok, 2006). However, since the bilinguals in this study are L1 language majorities immersed in a Chinese-speaking social and family environment, their lag in linguistic comprehension is not as pronounced as documented in previous literature on L1 minority bilinguals (see review, Melby-Lervåg & Lervåg, 2011; Cohen's $d = -1.12$). Consequently, while linguistic comprehension significantly influenced Chinese reading comprehension for these bilinguals, it was not as important as in studies involving L1 minority bilinguals (Lesaux et al., 2006; Melby-Lervåg & Lervåg, 2014).

Contrarily, the bilinguals in this study exhibited a large effect size in their word reading deficiency, which also held greater influence. Previous research has rarely reported significant delays in word reading skills among bilinguals with large effect sizes, regardless of whether they are L1 majority bilinguals (Jasińska & Petitto, 2018; Pawlicka et al., 2018) or L1 minority bilinguals (Melby-Lervåg & Lervåg, 2011). This novel finding in our study may highlight the impact of script features. According to the meta-analytical study conducted by Melby-Lervåg and Lervåg (2011), there is a strong correlation between students' L1 and L2 word reading skills when both scripts are alphabetic. Therefore, in previous studies on bilinguals learning two alphabetic scripts, students' word reading skills did not exhibit noticeable deficiencies as they may benefit from cross-linguistic transfer mechanism (Cummins, 1980; Koda, 2007). However, the bilinguals in our study face the challenge of learning English as an opaque alphabetic script and Chinese as a non-alphabetic script. Previous review studies (Melby-Lervåg & Lervåg, 2011; Yang et al., 2017) have reported a relatively weak correlation between Chinese and English word reading. Consequently, the bilinguals in our study may not benefit from positive transfer effects of learning English when developing Chinese word reading, and, conversely, become more vulnerable to the adverse effects of reduced Chinese learning time resulting from English immersion.

Second, this study further examined the predictors influencing students' word reading. While phonological awareness did not emerge as a unique factor, morphological awareness was identified as a significant and unique predictor for both groups. This finding aligns with prior research. Considering the nature of the Chinese writing system, which is not alphabetic and lacks a robust sound-to-grapheme mapping rule, although some studies (Chow et al., 2005; McBride-Chang & Zhong, 2003) supported the critical role of pre-literate phonological awareness in early Chinese character learning, other research (McBride-Chang et al., 2005; Yeung et al., 2011) involving middle and high primary students did not support its significance after controlling for other metalinguistic skills. In contrast, as indicated in prior cross-sectional studies (Liao et al., 2014; Liu

et al., 2017), morphological awareness consistently maintains its importance for Chinese word reading throughout the primary school years. Hence, even in higher grades, students may still rely on morphological awareness to extract meaning from Chinese characters, differentiate homophones and homographs, and facilitate character recognition through the orthographic-semantic-phonological pathway (Seidenberg & McClelland, 1989).

However, a notable difference between the two groups is that while orthographic awareness significantly influences monolinguals' word reading, it does not have an impact on bilinguals. Chinese characters are known for their complexity and vast quantity, making the importance of orthographic awareness in Chinese character learning a widely accepted notion (Peng et al., 2017). Even in higher grades, students need to recognize an increasing number of low-frequency compounding characters with more direct radical-to-sound correspondences (Shu et al., 1998). They still require orthographic awareness, particularly functional awareness of radicals, to facilitate Chinese character learning. Thus, consistent with previous studies (Liao et al., 2014; Liu et al., 2015), we also found that orthographic awareness remains a unique predictor in monolinguals even in upper primary grades.

However, the contribution of orthographic awareness is not significant in bilingual participants. This may be attributed to their lag in orthographic awareness, which hinders its utilization during the process of recognizing Chinese characters. These bilingual participants' underperformance in Chinese orthographic awareness could be the result of the substantial differences in orthographic structures between Chinese and English, which, as indicated by existing literature (Sun et al., 2018), do not support a positive cross-language transfer of orthographic skills. Hence, bilingual students may not benefit from their English learning to compensate for the reduced Chinese print exposure, leading to their delay in Chinese orthographic awareness. With their orthographic awareness lagging behind, bilingual students may reply more on holistic character recognition rather than effectively utilizing orthographic awareness and sub-lexical information to facilitate Chinese word reading.

Furthermore, this finding may also reflect the poor Chinese lexical representation quality among bilinguals. In addition to weaker orthographic representations, another distinct characteristic observed in bilinguals is the lack of a significant correlation between orthographic and morphological awareness, indicating a less reliable link between orthographic and morphological representations in bilinguals' lexicon. According to Tong and McBride-Chang's (2010) developmental models of Chinese word reading, while early learners tend to rely on associating sounds with prints and then retrieve meaning based on pronunciation, advanced readers tend to process the orthographic form and meaning of Chinese characters holistically, which may be a level of proficiency that these bilinguals have not yet achieved. Future research could further investigate bilinguals' lexicon via their reading errors or lexical decision tasks to provide additional insights for explaining their lag in Chinese reading.

Limitations and suggestions for future studies

While interpreting this study's results, certain limitations should be considered. First, the non-random sampling method employed might introduce sample biases and limit the generalizability of the conclusions, particularly regarding monolingual and bilingual comparisons (Rothman et al., 2008). Despite efforts to match the groups on factors like gender, age, and school district, socioeconomic status, a key bilingualism effect moderator (Bialystok, 2006; Melby-Lervåg & Lervåg, 2011), could not be sufficiently controlled due to data collection challenges. Indeed, fully addressing the comparability issue and isolating the effects of bilingualism has always been challenging (Bialystok, 2006). Thus, it is crucial not to oversimplify our findings as purely due to bilingualism. The unique traits of the bilinguals involved in this study, such as their high socioeconomic status and increased English learning need, should be considered. Future studies could focus on similar bilingual populations with better confounder control to replicate this study's findings. Second, the cross-sectional research design used limits causal relationship establishment. Future research should consider a longitudinal design to assess bilinguals' reading performance at different stages and explore the longitudinal associations between their reading and its predictors. Third, the current study compared age-matched bilinguals and monolinguals, who exhibit differences in various aspects of Chinese abilities. These differences are considered potential reasons for the varying relationships between Chinese reading and its predictors. However, beyond this, future research could also compare proficiency-matched bilingual and monolingual groups to examine if the predictors affecting their Chinese reading abilities still remain distinct, which would provide further insights into the uniqueness of bilinguals' reading learning process.

Conclusions

This study explored the unique predictor patterns of Chinese reading among Chinese–English bilingual children in mainland China compared to Chinese monolinguals. Despite these L1 majority bilinguals living in a Chinese social and home environment and acquiring Chinese literacy skills in school, we still discovered several distinct patterns in their Chinese reading compared to their Chinese monolingual peers. This finding reinforced the importance of investigating the unique reading development challenges and predictors in bilinguals and further underscored the need to expand such research focus to not only encompass the extensively studied L1 minority bilinguals, but also to include L1 majority bilinguals.

Additionally, this study uncovered a noteworthy deviation from previous research on bilinguals learning two alphabetic scripts that these Chinese–English bilinguals exhibited a greater lag in word reading, which had a stronger impact on their reading comprehension, as compared to their underperformance in linguistic comprehension. This discrepancy can potentially be attributed to the intricate nature of the Chinese writing system and the considerable linguistic differences between Chinese and English. It emphasizes the importance of recognizing the unique features of the

script and the linguistic distance between languages in the development of bilinguals' literacy skills.

Moreover, Chinese–English bilingual learners are present in many other regions worldwide, such as Chinese-native speaking children in Chinese-dominant regions (e.g., Hong Kong and Singapore) and Chinese-heritage speaking children in English-speaking regions. Compared to the bilingual children in mainland China discussed in this study, these learners might experience more English exposure in their social, home, or school environments, facing greater challenges in learning Chinese reading. While our findings cannot be generalized to describe these bilinguals' Chinese reading and its predictors, they highlighted the need for future research to explore the impact of varying degrees of Chinese–English bilingual experience across different dimensions to further deepen our understanding of the conditions necessary for Chinese reading development. Practically, educational stakeholders should be aware that Chinese–English bilingual children might lag in developing Chinese reading and its component skills due to reduced Chinese exposure and limited positive cross-language transfer. Sufficient Chinese learning time and environments should be allocated to allow students to establish Chinese language and literacy foundations when designing Chinese–English bilingual curriculums. Given the unique relationships between Chinese reading comprehension and its predictors exhibited in bilinguals compared to monolinguals, treating Chinese–English bilinguals as equivalent to their monolingual peers with identical Chinese reading curriculum standards is inappropriate. Instead, it is crucial to tailor Chinese reading instructions to meet the specific needs of bilingual children.

Declarations

References

Abu-Rabia, S. (2001). Testing the interdependence hypothesis among native adult bilingual Russian-English students. *Journal of Psycholinguistic Research, 30*(4), 437–455.

Apel, K., Wilson-Fowler, E. B., Brimo, D., & Perrin, N. A. (2012). Metalinguistic contributions to reading and spelling in second and third grade students. *Reading and Writing, 25*(6), 1283–1305.

August, D., & Shanahan, T. (2008). *Developing reading and writing in second-language learners: Lessons from the report of the national literacy panel on language-minority children and youth.* Routledge.

Babayigit, S. (2014). The relations between word reading, oral language, and reading comprehension in children who speak English as a first (L1) and second language (L2): A multigroup structural analysis. *Reading and Writing, 28*(4), 527–544.

Bialystok, E. (1993). Metalinguistic awareness: The development of children's representations of language. In C. Pratt & A. F. Garton (Eds.), *Systems of representation in children: Development and use* (pp. 211–233). John Wiley & Sons.

Bialystok, E. (2002). Acquisition of literacy in bilingual children: A framework for research. *Language Learning, 52*(1), 159–199.

Bialystok, E. (2006). The impact of Bilingualism on language and literacy development. In T. K. Bhatia & W. C. Ritchie (Eds.), *The Handbook of Bilingualism* (pp. 577–601). Blackwell Publishing Ltd.

Bialystok, E., Luk, G., & Kwan, E. (2005). Bilingualism, biliteracy, and learning to read: Interactions among languages and writing systems. *Scientific Studies of Reading, 9*(1), 43–61.

Braze, D., Katz, L., Magnuson, J. S., Mencl, W. E., Tabor, W., Van Dyke, J. A., & Shankweiler, D. P. (2016). Vocabulary does not complicate the simple view of reading. *Reading and Writing, 29*(3), 435–451.

Chall, J. S. (1996). *Stages of reading development* (2nd ed.). Harcourt Brace College.

Cheung, H., Chan, M., & Chong, K. (2007). Use of orthographic knowledge in reading by Chinese–English bi-scriptal children. *Language Learning, 57*(3), 469–505.

Chow, B.W.-Y., McBride-Chang, C., & Burgess, S. (2005). Phonological processing skills and early reading abilities in Hong Kong Chinese kindergarteners learning to read english as a second language. *Journal of Educational Psychology, 97*(1), 81–87.

Cimmiyotti, Caleb Bartholet, (2013). *Impact of Reading Ability on Academic Performance at the Primary Level.* [Unpublished Master's Theses], Dominican University. https://doi.org/10.33015/dominican.edu/2013.edu.18

Cooper, D. R., & Schindler, P. S. (2003). *Business research methods* (8th ed.). McGraw-Hill.

Cummins, J. (1980). The entry and exit fallacy in bilingual education. *NABE Journal, 4*(3), 25–59.

Dijk, T., & Kintsch, W. (1983). *Strategies of discourse comprehension.* Academic Press.

Duke, N. K., & Cartwright, K. B. (2021). The science of reading progresses: Communicating advances beyond the simple view of reading. *Reading Research Quarterly, 56*(1), S25–S44.

Ellis, E. M. (2008). Defining and investigating monolingualism. *Sociolinguistic Studies, 2*(3), 311–330.

Farrar, M. J., Ashwell, S., & Maag, L. (2005). The emergence of phonological awareness: Connections to language and theory of mind development. *First Language, 25*(2), 157–172.

Florit, E., & Cain, K. (2011). The simple view of reading: Is it valid for different types of alphabetic orthographies? *Educational Psychology Review, 23*(4), 553–576.

Geva, E., & Siegel, L. S. (2000). Orthographic and cognitive factors in the concurrent development of basic reading skills in two languages. *Reading and Writing, 12*(1), 1–30.

García, J. R., & Cain, K. (2014). Decoding and reading comprehension: A meta-analysis to identify which reader and assessment characteristics influence the strength of the relationship in English. *Review of Educational Research, 84*(1), 74–111.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*(1), 6–10.

Ho, C.S.-H., Zheng, M., Hsu, L. S. J., Kwok, J.C.-Y., McBride, C., & Waye, M. M. Y. (2017). Examining an extended simple view of reading in Chinese: The role of naming efficiency for reading comprehension. *Contemporary Educational Psychology, 51*, 293–302.

Hong Kong Examinations and Assessment Authority. (2021). 全港性系统评估: 中国语文聆听评估 (小学六年级) [Hong Kong Territory-wide System Assessment: Chinese Listening Assessment (Primary 6)]. Government of the Hong Kong Special Administrative Region.

Jasińska, K. K., & Petitto, L. A. (2018). Age of bilingual exposure is related to the contribution of phonological and semantic knowledge to successful reading development. *Child Development, 89*(1), 310–331.

Kang, J. Y. (2012). Do bilingual children possess better phonological awareness? Investigation of Korean monolingual and Korean-English bilingual children. *Reading & Writing, 25*(2), 411–431.

Koda, K. (2007). Reading and language learning: Cross-linguistic constraints on second language reading development. *Language Learning, 57*(s1), 1–44.

Lesaux, N. K., Lipka, O., & Siegel, L. S. (2006). Investigating cognitive and linguistic abilities that influence the reading comprehension skills of children from diverse linguistic backgrounds. *Reading and Writing, 19*, 99–131.

Li, Y., Kang, J. S., Wei, L., & Zhang, S. Y. (1992). 现代汉语形声字研究 [Research on modern Chinese pictophonetic characters]. *Application of Language and Characters, 01*, 74–83.

Li, H., Shu, H., McBride-Chang, C., Liu, H., & Peng, H. (2012). Chinese children's character recognition: Visuo-orthographic, phonological processing and morphological skills. *Journal of Research in Reading, 35*(3), 287–307.

Li, Y., Xiao, L., & Li, H. (2022). Self-teaching in Chinese: The roles of phonetic and semantic radicals in orthographic and vocabulary learning. *Journal of Research in Reading, 45*(1), 20–42.

Liao, C., Lee, K., Tsao, C., & Pai, K. (2014). Morphological awareness, phonological awareness, and orthographic skills in reading accuracy and reading fluency among Chinese elementary school children. *Psychological Testing, 61*(4), 489–508.

Lin, L.-C., & Johnson, C. J. (2016). Mandarin-English bilingual vocabulary development in an English-immersion preschool: How does it compare with monolingual development? *International Journal of Bilingualism, 20*(2), 173–189.

Liu, D., Chen, X., & Chung, K. K. (2015). Performance in a visual search task uniquely predicts reading abilities in third-grade Hong Kong Chinese children. *Scientific Studies of Reading, 19*(4), 307–324.

Liu, D., Li, H., & Wong, K. S. R. (2017). The anatomy of the role of morphological awareness in Chinese character learning: The mediation of vocabulary and semantic radical knowledge and the moderation of morpheme family size. *Scientific Studies of Reading, 21*(3), 210–224.

Liu, P. D., & McBride-Chang, C. (2010). What is morphological awareness? Tapping lexical compounding awareness in Chinese third graders. *Journal of Educational Psychology, 102*(1), 62.

Luk, G., & Bialystok, E. (2013). Bilingualism is not a categorical variable: Interaction between language proficiency and usage. *Journal of Cognitive Psychology, 25*(5), 605–621.

Marshall, J. C., & Morton, J. (1978). On the mechanics of EMMA. *The child's conception of language* (pp. 225–239). Berlin: Springer.

Melby-Lervåg, M., & Lervåg, A. (2011). Cross-linguistic transfer of oral language, decoding, phonological awareness and reading comprehension: A meta-analysis of the correlational evidence. *Journal of Research in Reading, 34*(1), 114–135.

Melby-Lervåg, M., & Lervåg, A. (2014). Reading comprehension and its underlying components in second-language learners: A meta-analysis of studies comparing first-and second-language learners. *Psychological Bulletin, 140*(2), 409.

McBride-Chang, C., Cho, J.-R., Liu, H., Wagner, R. K., Shu, H., Zhou, A., & Muse, A. (2005). Changing models across cultures: Associations of phonological awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea, and the United States. *Journal of Experimental Child Psychology, 92*(2), 140–160.

McBride-Chang, C., & Zhong, Y. (2003). A longitudinal study of effects of phonological processing, visual skills, and speed of processing on Chinese character acquisition among Hong Kong Chinese kindergartners. In C. McBride-Chang & H.-C. Chen (Eds.), *Reading development in Chinese children* (pp. 37–49). Praeger.

Ministry of Education of the People's Republic of China. (2022). 义务教育语文课程标准 [Chinese curriculum standards for compulsory education]. Beijing Normal University Press.

Mullis, I. V., & Martin, M. O. (2019). *PIRLS 2021 Assessment Frameworks*. International Association for the Evaluation of Educational Achievement. Herengracht 487, Amsterdam, 1017 BT, The Netherlands.

Nagy, W. E., & Anderson, R. C. (1995). Metalinguistic awareness and literacy acquisition in different languages. *Center for the Study of Reading Technical Report; no. 618*.

Newschool Insight Media. (2019). China International School Report Policy and Market Research. https://www.xinxueshuo.cn/#/research/download?id=16

Novita, S., Lockl, K., & Gnambs, T. (2021). Reading comprehension of monolingual and bilingual children in primary school: The role of linguistic abilities and phonological processing skills. *European Journal of Psychology of Education, 37*, 1–21.

OECD. (2013). OECD skills outlook: First results from the survey of adult skills. *OECD Publishing*. https://doi.org/10.1787/9789264204256-en

Papastefanou, T., Marinis, T., & Powell, D. (2021). Development of reading comprehension in bilingual and monolingual children—effects of language exposure. *Languages, 6*(4), 166.

Pawlicka, P., Lipowska, M., & Jurek, P. (2018). Bilingual advantage? Literacy and phonological awareness in Polish-speaking early elementary school children learning English simultaneously. *Acta Neuropsychologica, 16*, 27–46.

Peng, P., Lee, K., Luo, J., Li, S., Joshi, R. M., & Tao, S. (2021). Simple view of reading in Chinese: a one-stage meta-analytic structural equation modeling. *Review of Educational Research, 91*(1), 3–33. https://doi.org/10.3102/0034654320964198

Peng, P., Wang, C., Tao, S., & Sun, C. (2017). The deficit profiles of Chinese children with reading difficulties: A meta-analysis. *Educational Psychology Review, 29*, 513–564.

Perfetti, C. A. (2003). The universal grammar of reading. *Scientific studies of reading, 7*(1), 3–24.

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*(1), 22–37.

Perfetti, C. A., Zhang, S., & Berent, I. (1992). Reading in English and Chinese: Evidence for a "universal" phonological principle. In A. M. Columbus (Ed.), *Advances in psychology* (Vol. 94, pp. 227–248). Nova Science Publishers Inc.

Protopapas, A., Mouzaki, A., Sideridis, G. D., Kotsolakou, A., & Simos, P. G. (2013). The role of vocabulary in the context of the simple view of reading. *Reading & Writing Quarterly, 29*(2), 168–202.

Quinn, J. M., & Wagner, R. K. (2018). Using meta-analytic structural equation modeling to study developmental change in relations between language and literacy. *Child Development, 89*(6), 1956–1969. https://doi.org/10.1111/cdev.13049

Rothman, K. J., Greenland, S., & Lash, T. L. (2008). *Modern epidemiology* (3rd Ed.). Wolters Kluwer Health/Lippincott Williams & Wilkins.

Ruddell, R. B. and N. Unrau (2004). *Theoretical models and processes of reading*. Newark, DE, International Reading Association.

Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review, 96*(4), 523.

Shu, H., Wu, N. N., Zheng, X. J., & Zhou, X. L. (1998). A study on the phonetic characteristics and distribution of Chinese phonetic characters in primary schools. *Applied Linguistics, 2*, 65–60.

Smith, C. L., & Tager-Flusberg, H. (1982). Metalinguistic awareness and language development. *Journal of Experimental Child Psychology, 34*(3), 449–468.

Sun, B., Hu, G., & Xiao Lan, C.-C. (2020). Metalinguistic contribution to reading comprehension: A comparison of Primary 3 students from China and Singapore. *Applied Psycholinguistics, 41*(3), 657–684.

Sun, C., Branum-Martin, L., Peng, P., & Tao, S. (2018). Phonology, orthography, and decoding skills within and across english and Chinese. *Scientific Studies of Reading, 22*(5), 401–419.

Surrain, S., & Luk, G. (2019). Describing bilinguals: A systematic review of labels and descriptions used in the literature between 2005–2015. *Bilingualism: Language and Cognition, 22*(2), 401–415.

Tong, X., & McBride-Chang, C. (2010). Developmental models of learning to read Chinese words. *Developmental Psychology, 46*(6), 1662–1676.

Tong, X., Tong, X., & McBride, C. (2017). Radical sensitivity is the key to understanding Chinese character acquisition in children. *Reading and Writing, 30*(6), 1251–1265.

Tse, S. K., Loh, K. Y. E., Lam, Y. H. R., & Lam, W. I. J. (2010). A comparison of english and Chinese reading proficiency of primary school Chinese students. *Journal of Multilingual and Multicultural Development, 31*(2), 181–199.

Wan, Z., & Gao, X. (2021). 'Home away from home': Understanding Chinese parents' ideological beliefs and involvement in international school students' language learning. *Current Issues in Language Planning, 22*(5), 495–515.

Wang, L., & Liu, D. (2020). The role of morphological awareness in reading Chinese characters: The moderating effect of morpheme family size. *Scientific Studies of Reading, 24*(2), 170–178.

Williams, K. T., Wang, J.-J., & Dunn, L. M. (1997). *Technical references to the Peabody picture vocabulary test–Third edition (PPVT-III)*. American Guidance Service.

Wong, Y. K., & Zhou, Y. (2022). Effects of metalinguistic awareness on Chinese as a second language spelling through the mediation of reading and copying. *Reading and Writing, 35*(4), 853–875.

Wong, Y. K., Zang, X., & Inoue, T. (2023). Promoting foundational linguistic skills for reading development in young Chinese language learners: A 1-year intervention study. *Journal of Research in Reading*, *46*(3), 247–277.

Yang, M., Cooc, N., & Sheng, L. (2017). An investigation of cross-linguistic transfer between Chinese and English: a meta-analysis. *Asian-Pacific Journal of Second and Foreign Language Education, 2*(1), 31–37.

Ye, Y., Yan, M., Ruan, Y., McBride, C., Zheng, M., & Yin, L. (2022). Exploring the underpinnings and longitudinal associations of word reading and word spelling: A 2-year longitudinal study of Hong Kong Chinese children transitioning to primary school. *Scientific Studies of Reading, 26*(1), 21–37.

Yeung, P.-S., Ho, C.S.-H., Chan, D.W.-O., & Chung, K.K.-H. (2016). A componental model of reading in Chinese. *Learning & Individual Differences, 45*, 11–24.

Yeung, P.-S., Ho, C.S.-H., Chik, P.P.-M., Lo, L.-Y., Luan, H., Chan, D.W.-O., & Chung, K.K.-H. (2011). Reading and spelling Chinese among beginning readers: What skills make a difference? *Scientific Studies of Reading, 15*(4), 285–313.

Zhang, J., McBride-Chang, C., Tong, X., Wong, A. M. Y., Shu, H., & Fong, C. Y. C. (2012). Reading with meaning: The contributions of meaning-related variables at the word and subword levels to early Chinese reading comprehension. *Reading and Writing, 25*(9), 2183–2203.