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How does word knowledge facilitate reading comprehension in a second language? A longitudinal study in Chinese primary school children learning English

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Abstract

This study aims to advance our understanding of the role of word knowledge in second language (L2) reading comprehension by exploring whether morphological awareness and vocabulary assessed one year ago contribute to decoding and listening comprehension which in turn contribute to reading comprehension in Chinese children learning English as an L2. A total of 167 Grade 3 and 4 primary school students ($M_{age} = 8.99$ years) in Hong Kong were tested on English morphological awareness and vocabulary at Time 1, and they were also tested on English decoding, listening comprehension, and reading comprehension at Time 2, one year later. Our regression models showed that word knowledge tested at Time 1 was a significant predictor of decoding, listening comprehension, and reading comprehension at Time 2; and word knowledge explained more variance in decoding, listening comprehension, and reading comprehension in children who had higher levels of word knowledge. The results of structural equation modeling indicated that vocabulary contributed to reading comprehension fully through decoding and listening comprehension. Morphological awareness contributed to reading comprehension partially through vocabulary and decoding, and it also had a unique direct contribution to reading comprehension. The findings from this study suggested the importance of emphasizing word knowledge in developing children's reading comprehension in an L2 at an early stage of learning to read.

Keywords Morphological awareness · Vocabulary · Decoding · Language comprehension · Reading comprehension

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Mastering English is vital in today's globalized world. For children who learn English as a second language (L2) in their home country and whose first language (L1) is rather different from English in phonology and orthography, learning to read in English is likely to be a quite challenging task. However, the development of reading comprehension in English in these children remains underexplored. Therefore, this study aims to advance our understanding of reading comprehension in Chinese children who learn English as an L2.

One of the most widely recognized theoretical models for understanding reading comprehension is the Simple View of Reading Model (Gough & Tunmer, 1986; Hoover & Gough, 1990). This model posits that decoding and spoken language comprehension are two critical components underpinning reading comprehension. Decoding depends on mastering the relation between letter-sound correspondence rules, while language comprehension and reading comprehension both involve the ability to understand meaning (Gough & Tunmer, 1986; Hoover & Gough, 1990). The Simple View of Reading Model is widely validated in various languages such as English, Italian, Greek, and Chinese (Florit & Cain, 2011; Kendeou et al., 2013; Tobia & Bonifacci, 2015; Yeung et al., 2016), and it has been shown that decoding and language comprehension accounted for 40% to 83% of the variance in reading comprehension (e.g., Ho et al., 2019; Joshi & Aaron, 2000; Kendeou et al., 2013). Decoding is especially critical at the beginning stage of learning to read, enabling learners to acquire how the writing system represents spoken language; while in advanced learners, for whom decoding has become automatic, language comprehension is more important in reading comprehension (Catts et al., 2003; Hoover & Gough, 1990; Perfetti, 1985).

Several theoretical frameworks have extended the Simple View of Reading Model by indicating the importance of word knowledge in reading comprehension. According to a framework for comprehension put forward by Perfetti et al. (2005), language comprehension can be classified into word level (lexical processes), sentence level (syntactic processes), and higher text level. At the word level, morphemes and vocabulary knowledge enables us to understand the meanings of words. At the sentence level, the knowledge of syntax is added to word level knowledge. Comprehension skills at higher text level add oral inferential comprehension and text structure to sentence level knowledge. These skills include sensitivity to story structure, inference making, and comprehension monitoring (Perfetti et al., 2005). According to this framework, word level comprehension processes are important as they affect the effectiveness and efficiency of higher levels of comprehension processes. In a more recent Direct and Indirect Effects Model of Reading (Kim, 2020), vocabulary and grammar were regarded as foundational oral language skills, and they support higher order cognition and regulations, such as inference making and comprehension monitoring while at the same time interacting with phonology and semantics in word reading. According to the Lexical Quality Hypothesis (Perfetti & Hart, 2001), a high quality word representation integrates phonological, orthographic, and semantic information. The lack of any of these components leads to the lower quality of word representation. The quality of a word representation not only affects comprehension but also determines the degree of automaticity of word identification in reading comprehension. Furthermore, the Reading Systems Framework highlights the role of the lexicon (including word meaning, morphology, and syntax) in reading comprehension as the lexicon bridges the word identification and comprehension systems. In all these frameworks, word knowledge such as vocabulary and morphology are emphasized in reading comprehension. Vocabulary size (breadth) refers to how many words learners know (Li & Kirby, 2015). Morphological awareness refers to the understanding and manipulation of the smallest semantic meaning (Kuo & Anderson, 2006) and is regarded as one feature of vocabulary depth denoting how well words are known (Li & Kirby, 2015). For example, by understanding the suffix "er", people understand that the word "driver", which originates from the word "drive", refers to a profession. A number of empirical studies also have demonstrated that vocabulary and morphological awareness are critical predictors of reading comprehension and reading comprehension growth in L1 and L2 (e.g., Lervåg & Aukrust, 2010; Zhang & Koda, 2012).

However, the specific role of vocabulary breadth and morphological awareness in reading comprehension is still unclear. Several studies have shown that morphological awareness had a unique direct contribution to reading comprehension when decoding and vocabulary were controlled for, suggesting that morphological awareness may play multiple roles in reading comprehension (e.g., Kieffer & Lesaux, 2012; Li et al., 2017). However, the multiple roles of morphological awareness are largely unknown. The role of vocabulary in reading comprehension also remains unclear. Several studies showed that vocabulary had a unique contribution to reading comprehension after decoding and listening comprehension were controlled for (Braze et al., 2007; Tunmer & Chapman, 2012); whereas some other studies showed that vocabulary should be regarded as one part of language comprehension (Braze et al., 2016).

In addition, the role of vocabulary and morphological awareness in reading comprehension in L2 is rather underexplored, and there is a general lack of longitudinal studies exploring vocabulary and morphological awareness as predictors of reading comprehension in children who learn an L2 in their home country. Vocabulary and morphological awareness may be more important in reading comprehension in these children especially when their L2 is highly distinct from L1 in phonology. These children may have limited exposure in the L2 as their L1 is usually predominantly used in the societies they live. In addition, a substantial amount of L2 phonology may be novel to them. For example, Mandarin Chinese has a short inventory of 410 syllables and Cantonese has 630 syllables without considering tones (Duanmu, 2007), whereas English has more than 10,000 syllables and more complicated syllabic structures (Crystal, 1995). For Chinese children who learn English as an L2, they firstly need to acquire L2 words defining the novel L2 phonological forms, and vocabulary can serve as a critical source for the acquisition and analysis of phonological knowledge (San Francisco et al., 2006). Based on the L2 phonological knowledge, they can further develop decoding and listening comprehension. It is likely that the role of word knowledge is especially important for children to develop language and reading skills in an L2; hence, the current study employs a longitudinal study design to explore the contribution of word knowledge to reading comprehension in Chinese primary school children who learn English as an L2.

The contribution of vocabulary to reading comprehension

Most of the studies that explored the relation between vocabulary and reading comprehension focused on vocabulary breadth which is usually assessed via receptive and expressive vocabulary (Li & Kirby, 2015). The association between vocabulary and reading comprehension has constantly been shown (e.g., Protopapas et al., 2013; Tunmer & Chapman, 2012; Xie & Yeung, 2022). Children who have limited vocabulary may have problems in understanding texts. The meaning of unknown words can be inferred from reading context; however, too many unknown words may lead to break down in comprehension (Carver, 1994). This indicates that vocabulary supports language comprehension, and some scholars viewed vocabulary as a language comprehension component in the Simple View of Reading Model (e.g., Braze et al., 2016; Gottardo et al., 2018; Ho et al., 2019). Several studies have shown that vocabulary contributed to reading comprehension partially through listening comprehension (Proctor et al., 2005; Verhoeven et al., 2019).

Vocabulary is also found to be important for developing decoding skill (Nation & Snowling, 1998; Plaut et al., 1996). Knowing the phonology and meaning of a word can facilitate the acquisition and recognition of that word in the written form through phonology-orthography correspondence (Elbro et al., 2012) and through linking the learned orthography (prints) with the linguistic semantics more efficiently. If vocabulary serves as a foundation for learners to develop decoding and language comprehension, it may also predict the development of reading comprehension. A few longitudinal studies showed that vocabulary did predict reading comprehension growth (e.g., Oakhill & Cain, 2012; Proctor et al., 2005; Quinn et al., 2020).

Vocabulary may have a unique contribution to reading comprehension as several studies using regression found that vocabulary breadth had a small but significant unique effect on reading comprehension after controlling for decoding and listening comprehension (Braze et al., 2007; Tunmer & Chapman, 2012). In addition, Ouellette and Beers' (2010) study indicated that the contribution of vocabulary to reading comprehension may vary as a function of stage of reading development. They found that vocabulary breadth and depth had a unique predictive power for reading comprehension after controlling for phonological awareness, word decoding, and listening comprehension only among Grade 6 students but not among Grade 1 students who were novice readers.

There are far fewer studies exploring the relation between vocabulary and reading comprehension in an L2. Learners' vocabulary size in an L2 is usually smaller and associative links between words are fewer, relative to an L1 (Verhoeven, 2000; Vermeer, 2001). Several scholars compared L1 and L2 learners and found that vocabulary was more important in reading comprehension in an L2 relative to an L1 (Babayiğit & Shapiro, 2019; Droop & Verhoeven, 2003; Lervåg &

Aukrust, 2010). For example, Babayiğit and Shapiro (2019) investigated both primary school children who spoke English as their L1 and bilingual children who learned English as an L2 with various L1 backgrounds. They found that in English (L1)-speaking children, their receptive vocabulary fully contributed to reading comprehension through the mediation of listening comprehension, whereas in the bilingual children, vocabulary had a direct effect on reading comprehension along with the indirect effect through listening comprehension. A longitudinal study by Lervåg and Aukrust's (2010) showed that vocabulary breadth and depth appeared to be a stronger predictor of reading comprehension growth in children who learned Norwegian as an L2 than in Norwegian (L1)-speaking children. However, all these studies focused on immigrant children whose L2 was the predominant language used in the societies they lived in and, hence, their social environment might accelerate their learning of the L2. There is a general lack of longitudinal studies that investigate the effect of vocabulary on the development of decoding, language comprehension, and reading comprehension among children who learn an L2 in their home country.

The contribution of morphological awareness to reading comprehension

Morphological awareness has been found to be a critical skill in understanding and learning new words (e.g., Kuo & Anderson, 2006; McBride-Chang et al., 2006). In addition, derivational morphological awareness in many languages also facilitates word decoding (De Freitas et al., 2018; Qiao et al., 2021) as many words contain morphological components in their orthography that can be used to parse the word in written word recognition (e.g., Levesque et al., 2017). For example, readers may infer that the word "psychologist" refers to a profession from the morpheme of "ist". Chinese readers may infer that the characters 鰭 (fin) and 鰓 (gill) are relevant to fish from their morpheme of 魚 (fish).

Morphological awareness is also an important influence on reading comprehension (Perfetti et al., 2005). Several studies have shown that morphological awareness contributed to reading comprehension partially through vocabulary and word decoding, and it also had a unique direct contribution to reading comprehension (Deacon et al., 2014; Kieffer et al., 2013). This suggests that morphological awareness may play multiple roles in reading comprehension (e.g., Kieffer & Lesaux, 2012; Li et al., 2017). It could be that morphological awareness also contributes to comprehension skills via facilitating the syntactic process and comprehension monitoring. Morphemes in an alphabetic language such as English can indicate grammatical information. For example, derivational morphemes can identify the grammatical forms of a word (e.g., whether a word is a noun, adjective, or verb), and inflectional morphemes are used to refer to the grammatical function of a word, such as plural form and tense (Oz, 2013). Further, Perfetti et al.'s (2005) model of reading comprehension indicated that manipulation of morphological clues for text comprehension may be involved in comprehension monitoring that entails metacognitive processes enabling readers to identify and then repair the comprehension inconsistent with their prior knowledge and mental representation (Perfetti et al., 2005). For example, children may infer that the sentence “A cat leaps out of the window; therefore, he was injured” was grammatically incorrect from the morphological clues of “s” (which indicates a present tense) and “ed” (which indicates a past tense). Since syntactic comprehension and comprehension monitoring are entailed in language comprehension process (Perfetti et al., 2005), we assumed that the unique contribution of morphological awareness to reading comprehension showed in previous studies (Deacon et al., 2014; Kieffer et al., 2013; Li et al., 2017) could be at least partially explained by its contribution to language comprehension. In addition, morphological awareness may have a unique contribution to reading comprehension through facilitating the understanding of unfamiliar words in reading contexts as implicated by Paribakht and Wesche’s (1999) study. In this study, Paribakht and Wesche (1999) interviewed university English learners who learned new words incidentally through reading thematically related texts and found that these English learners could use derivational and inflectional morphology to infer the meaning of unknown words from texts.

The majority of studies investigating the contribution of morphological awareness to reading comprehension focused on an L1, and the studies focusing on an L2 are far fewer. Several studies focusing on an L2 showed that morphological awareness contributed to reading comprehension through vocabulary (e.g. Bae & Joshi, 2018; Zhang & Koda, 2012). Some studies further showed that morphological awareness may have a unique contribution to reading comprehension in an L2 beyond vocabulary (e.g., Kieffer & Lesaux, 2008, 2012; Wang et al., 2006, 2009). In addition, a longitudinal study by Kieffer and Lesaux (2008) in Spanish–English bilingual children in the U.S. found that children’s English derivational morphological awareness in Grade 4 predicted their reading comprehension in Grade 5 when the initial scores of word reading skills, phonological awareness, and vocabulary knowledge were controlled for as auto-regressor variables.

The present study

This study explores how word knowledge longitudinally contributes to reading comprehension in Chinese children who were at an early stage of learning English in a Chinese region. The research question is “How does word knowledge, assessed through vocabulary and morphological awareness one year ago, contribute to reading comprehension in an L2, after controlling for decoding and language comprehension?”.

We hypothesized that word knowledge predicts reading comprehension assessed one year later through the mediation of decoding and listening comprehension. In addition, word knowledge, especially morphological awareness, was expected to have a unique direct contribution to reading comprehension measured one year later. The hypotheses were made based on the empirical evidence introduced above (e.g., Babayiğit & Shapiro, 2019; Kieffer & Lesaux, 2012; Paribakht & Wesche, 1999) and the current theoretical frameworks which suggest that word knowledge interacts with both decoding and language comprehension (Kim, 2020; Perfetti & Hart, 2001; Perfetti & Stafura, 2014).

Methods

Participants

A total of 167 students (77 girls) with the mean age of 8.99 years old ($SD = 0.59$) in a public primary school in Hong Kong participated in Time 1 of this study in December of 2018. Among these students, 87 were in Grade 3 and 80 were in Grade 4. These children also participated in Time 2 one year later. Parental education levels ranged from Primary Education to Doctorate Degree with a median of Senior Secondary Education.

These children spoke Cantonese as their L1, and English was taught as a subject in their school for around 6–8 h every week. In Hong Kong, local children typically begin to learn English as an L2 in kindergarten. As Cantonese is predominantly used in the society of Hong Kong, children at primary school are still at an early stage of learning English.

Measures

Students completed a number of English language (L2) tasks. Receptive and expressive vocabulary tasks were administered to measure vocabulary breadth (e.g., Li & Kirby, 2015). Reading accuracy and fluency tasks have been commonly used to assess decoding skills (e.g., Florit & Cain, 2011) and, therefore, were used in this study. Both vocabulary and decoding were assessed by two measures as using multiple measures to indicate one construct may lead to less measurement error when conducting structural equation modeling (SEM) (Kline, 2015). Morphological awareness and vocabulary size were tested at Time 1. Word reading accuracy and fluency, listening comprehension, and reading comprehension were tested at Time 2.

Morphological Awareness

We used the Test of Morphological Structure (Carlisle, 2000) to assess children's derivational morphological awareness in English. Derivational morphology refers to the formation of lexemes, and it bridges phonology and orthography (Bahr et al., 2020); therefore, it was regarded as an important aspect of word knowledge and measured in this study. In this task, children were asked to use and manipulate a target word to complete a sentence presented in print (e.g., Width. The mouth of the river is very _____.) There were 2 trial items and 20 testing items. Each correct answer was allotted 1 point.

Receptive Vocabulary

This task was adapted from The Peabody Picture Vocabulary Test—4th edition (PPVT-4; Dunn & Dunn, 2007). Each time a tester orally presented a target word, and the child was required to point to one of four pictures that best corresponded to that word. There were 24 items, and each correct answer received 1 point.

Expressive Vocabulary

We used the first 15 items in the Expressive Picture Vocabulary subtest of the Clinical Evaluations of Language Fundamentals—5th Edition (CELF-5; Wiig et al., 2013). In this task, children were presented with pictures, and they had to name the pictures in English. Each answer was scored from 0 to 2 points. For several items, 1 point was scored if a child's answer was partially correct (e.g., saying "award" instead of the correct answer "trophy").

Word Reading Accuracy

Two tests were used to assess word reading accuracy performance. The first test was adapted from Tong and McBride-Chang (2010) that contains a list of 60 printed English words. The second test contains a list of 35 printed English words adapted from Test 1 (Letter-Word Identification) of Woodcock-Johnson III Test of Achievement (Woodcock et al., 2001). The difficulty levels of both the tests gradually increased. Participants were provided with both the tests and started with Tong and McBride-Chang's (2010) test. They were asked to read aloud the printed words one after another. When a participant misread five consecutive items on either of the tests, that test stopped. Each correct answer received 1 point, and we combined the scores of the two tests to indicate the performance of word reading accuracy.

Word Reading Fluency

We used the Sight Word Efficiency (SWE) subset of the Test of Word Reading Efficiency (Torgesen et al., 1999) to assess the children's word reading fluency. In this task, children were presented with a list of 104 printed English words with increasing difficulty. Children had to read as many words as possible within 45 s.

Listening Comprehension

A listening comprehension task is commonly used to assess language comprehension (e.g., Braze et al., 2016; Ouellette & Beers, 2010). We adapted the Understanding

Spoken Paragraphs subset from the Clinical Evaluation of Language Fundamentals—4th edition (CELF-4; Semel et al., 2006) to assess children's listening comprehension in English. Three stories in this subtest designed for children aged from 7 to 8 years were selected. Children were orally presented with a story, followed by five oral questions, among which three were about the main idea, details, and sequence of the story. The remaining two questions required inference (e.g., "Why was Marcus worried?") and prediction making (e.g., "Who do you think Marcus will miss seeing while he's at school on the first day?). Children were provided with a trial at the beginning to familiarize themselves with the task. Each correct answer merited 1 point.

Reading comprehension

This task was developed among primary school children in Hong Kong by Tong and her colleagues (2018). In this task, children had to answer comprehension questions within 35 min. The first passage was of expository type, and the second one was of narrative type. Each passage was followed by 12 multiple-choice questions and 3 short answer questions. These questions were designed to assess children's basic, broad, and in-depth comprehension of the text content (Tong et al., 2018). Several short answer questions additionally required inference making (e.g., Is Jim really in his room? How do you know that?) Each correct answer to the multiple-choice question was allotted 1 point. The short answer questions were scored according to the coding scheme determined by Tong et al. (2018). Each correct answer received 1 point, and 0.5 point was provided to a partially correct answer (e.g., providing the answer as "The weather is hot." instead of the correct answer "Sometimes the weather is hot even when it is winter." to the question "What is meant by 'People can also have summer in winter'?"). The maximum score for this task was 30 points.

Procedures

The above-mentioned language tasks were provided to these participants in their school during several sessions, and well-trained experimenters tested the participants. Each session took between 40 and 60 min. A few students were absent at different sessions and did not complete all the assessments. This leads to different numbers of missing data for the measures administered. A total of 139 students completed all the measures in the two times.

Research ethical approval and consent from the parents were obtained before this study was conducted. The audio stimuli used for the receptive vocabulary and listening comprehension tasks were pre-recorded using a female native English speaker's voice. Measures requiring oral responses were conducted individually by trained research assistants. The morphological awareness, receptive vocabulary, and reading comprehension tasks were administered in groups with each group consisting of about 20 children.

Table 1 Descriptive statistics

Variables	*n*	Score Range	Mean	*SD*	Cronbach's α	Skewness	Kurtosis
T1 morphological awareness	163	0–17	3.49	3.37	.86	.96	1.11
T1 receptive vocabulary	163	3–23	11.86	4.50	.77	.25	− .52
T1 expressive vocabulary	163	0–25	10.06	5.12	.72	.98	1.19
T2 word reading accuracy	161	0–93	34.45	21.44	.98	.68	− .08
T2 word reading fluency	155	0–86	42.58	17.45	.98	− .29	.00
T2 listening comprehension	151	0–14	3.86	3.36	.82	.70	− .38
T2 reading comprehension	163	0–28	13.61	7.42	.91	.17	-1.08

T1 = Time 1; T2 = Time 2

Table 2 Partial correlations controlling for grade

		1	2	3	4	5	6	7
1	T1 Morphological awareness	–						
2	T1 Receptive vocabulary	.47	–					
3	T1 Expressive vocabulary	.57	.60	–				
4	T2 Word reading accuracy	.65	.55	.68	–			
5	T2 Word reading fluency	.61	.52	.58	.84	–		
6	T2 Listening comprehension	.46	.53	.56	.58	.52	–	
7	T2 Reading Comprehension	.60	.47	.55	.64	.63	.56	–

All the correlations are significant ($p < .001$). T1 = Time 1; T2 = Time 2

Results

Descriptive statistics are presented in Table 1. All the measures had good internal consistency as shown by the Cronbach's α values which were above 0.70 (Cortina, 1993). The scores on all the measures were generally normally distributed as shown by the absolute values of skewness and kurtosis smaller than 2.00 (Gravetter & Wallnau, 2014).

We conducted partial correlations among all the variables controlling for grade (Table 2). Complete case analysis was used to deal with the missing data. Morphological awareness was significantly correlated with receptive and expressive vocabulary ($r \geq 0.47$, $p < 0.001$). In addition, morphological awareness, receptive vocabulary, and expressive vocabulary correlated significantly with word reading accuracy and fluency ($r \geq 0.52$, $p < 0.001$), listening comprehension ($r \geq 0.46$, $p < 0.001$), and reading comprehension ($r \geq 0.47$, $p < 0.001$) tested in Time 2. In addition, receptive and expressive vocabulary were substantially correlated ($r = 0.60$, $p < 0.001$), and word reading accuracy and fluency were strongly correlated ($r = 0.84$, $p < 0.001$).

To examine to what degree the variance in Time 2 decoding, listening comprehension, and reading comprehension could be explained by morphological awareness and vocabulary, we conducted three hierarchical regression models with Time

Table 3 Hierarchical regression

	Step	Predictor	T2 decoding				T2 Listening comprehension				T2 reading comprehension			
			b	*SE (b)*	*β*	*Δ R*²	*b*	*SE (b)*	*β*	*Δ R*²	*b*	*SE (b)*	*β*	*Δ R*²
Whole sample	1	Grade	−.570	.313	−.149	.022	−.883	.560	−.132	.017	−.894	1.196	−.060	.004
	2	T1 morphological awareness	.223	.038	.393***	.551***	.160	.080	.160*	.387***	.872	.165	.395***	.437***
		T1 vocabulary	.486	.073	.450***		.992	.154	.523***		1.489	.317	.355***	
Low WK	1	Grade	.160	.341	.055	.003	−.096	.524	−.022	.000	1.622	1.273	.147	.022
	2	T1 morphological awareness	.263	.093	.263**	.173***	.122	.149	.095	.095*	1.058	.347	.332**	.166***
		T1 vocabulary	.515	.170	.515**		.725	.272	.312**		1.761	.634	.304**	
High WK	1	Grade	−.086	.407	−.025	.001	.324	.825	.048	.002	.544	1.609	.039	.002
	2	T1 morphological awareness	.199	.050	.390***	.458***	.062	.123	.060	.199***	.691	.237	.326**	.216***
		T1 vocabulary	.463	.107	.433***		.913	.263	.428***		1.038	.506	.234*	

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

T1 = Time 1; T2 = Time 2. WK = word knowledge

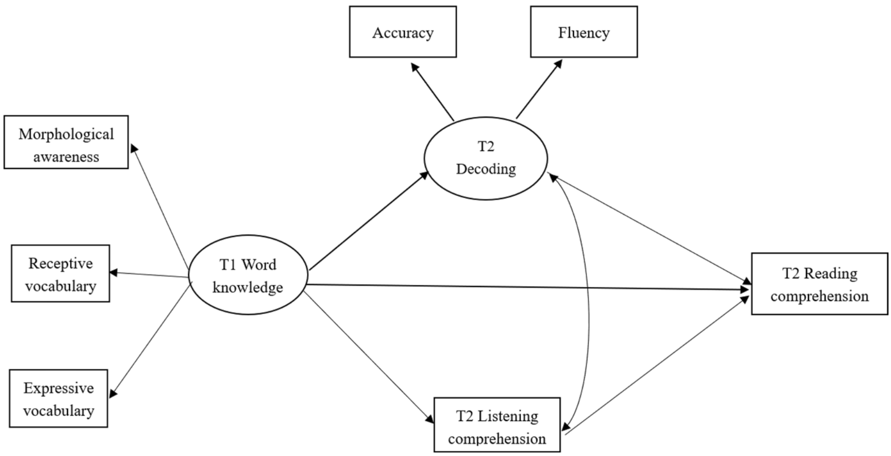

Fig. 1 Conceptual model 1. *Note*. T1 = Time 1; T2 = Time 2

2 decoding, listening comprehension, and reading comprehension as the dependent variables, respectively (see Table 3). Pairwise deletion was used to deal with the missing data, and the assumption of linearity was applied. We used the decoding composite score calculated by the sum of the *z* scores of word reading accuracy and fluency. In a similar vein, the composite score of vocabulary size was the combination of the *z* scores of receptive and expressive vocabulary. Grade was entered in all the three regression models as the first step, but it did not significantly account for the variance in decoding, listening comprehension, and reading comprehension. Time 1 morphological awareness and vocabulary were entered in all the three models as the second steps, and they accounted for notable variance in Time 2 decoding (55.1%), listening comprehension (38.7%), and reading comprehension (43.7%).

The hierarchical regression models were conducted again based on children's word knowledge scores (Table 3), which were indicated by the sum of the *z* scores of morphological awareness, receptive and expressive vocabulary. Children who obtained the median scores or lower were classified into the low word knowledge group ($n = 77$), and those whose score were higher than the median were classified in the high word knowledge group ($n = 78$). We found that although morphological awareness and vocabulary explained significant variance in decoding, listening comprehension, and reading comprehension in both the groups, they explained more variance in decoding, listening comprehension, and reading comprehension in the high word knowledge group (respectively 45.8%, 19.9%, and 21.6%) than in the low word knowledge group (17.3%, 9.5%, 16.6%).

In the following, we conducted SEM by using MPlus 8.1 to explore whether and how morphological awareness and vocabulary tested in Time 1 predicted reading comprehension tested in Time 2 through decoding and listening comprehension. Maximum likelihood estimation was used. The latent decoding factor in the SEM was indexed by word reading accuracy and fluency. In the first alternative model, morphological awareness, receptive and expressive vocabulary scores were the

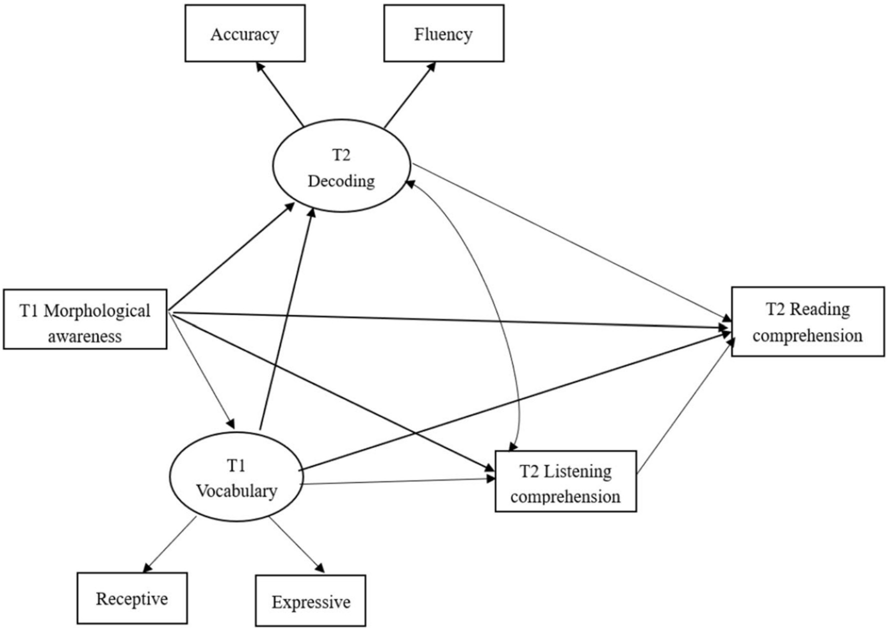

Fig. 2 Conceptual Model 2. *Note.* T1 = Time 1; T2 = Time 2

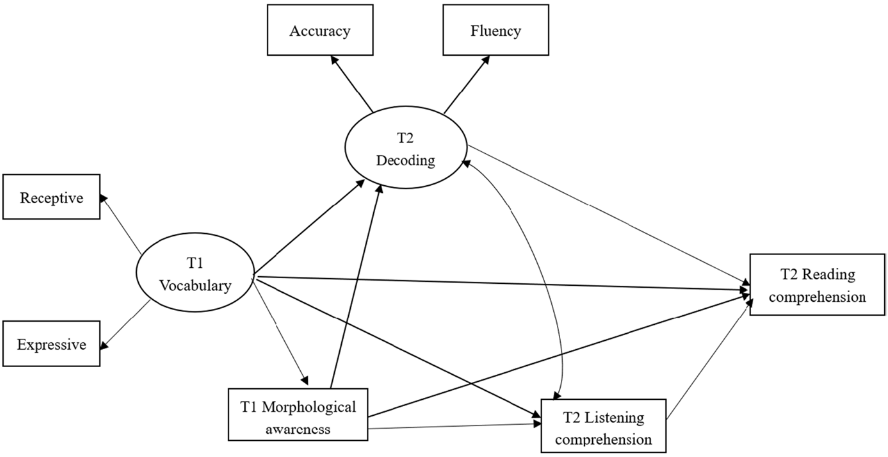

Fig. 3 Conceptual Model 3. *Note.* T1 = Time 1; T2 = Time

indicators of the latent word knowledge variable (Fig. 1). A good model fit is usually indicated by CFI and TLI values larger than 0.95, RMSEA values lower than 0.05, and the non-significant value of $\chi^{2/df}$; and an acceptable model fit is indicated by CFI and TLI values larger than 0.90 and RMSEA values lower than 0.08 (e.g., Bollen

Table 4 Standardized regression weights for the alternative model 2

Path	*β*	*SE*	*p*
Factor loadings in the measurement model			
Receptive ← T1 vocabulary	.724	.047	.000
Expressive ← T1 vocabulary	.807	.041	.000
Accuracy ← T2 decoding	.957	.018	.000
Fluency ← T2 decoding	.888	.023	.000
Regression weights in the structural model			
T1 Vocabulary ← T1 morphological awareness	.678	.057	.000
T2 Decoding ← T1 morphological awareness	.205	.098	.037
T2 Decoding ← T1 vocabulary	.709	.096	.000
T2 Listening comprehension ← T1 morphological awareness	−.037	.114	.746
T2 Listening comprehension ← T1 vocabulary	.750	.112	.000
T2 Decoding ←→ T2 Listening comprehension	.028	.154	.857
T2 Reading comprehension ← T1 morphological awareness	.211	.083	.011
T2 Reading comprehension ← T1 vocabulary	.128	.208	.538
T2 Reading comprehension ← T2 decoding	.304	.155	.049
T2 Reading comprehension ← T2 listening comprehension	.198	.098	.044

T1 = Time 1; T2 = Time 2

& Long, 1993). Therefore, the fit of this model was acceptable: $\chi^2(10) = 15.570$ ($p > 0.05$), CFI = 0.99, TLI = 0.98, RMSEA = 0.06 (90% CI from 0.00 to 0.11).

In the second and third alternative models (Figs. 2 and 3), we separated the contribution of morphological awareness and vocabulary. The latent vocabulary factor was indexed by receptive and expressive vocabulary scores. In the second alternative model, we tested the effect of morphological awareness on vocabulary (Fig. 2); whereas in the third alternative model, we tested the effect of vocabulary on morphological awareness (Fig. 3). According to the model fit indices (Bollen & Long, 1993), the second model fit our data well: $\chi^2(7) = 6.159$ ($p > 0.05$), CFI = 1.00, TLI = 1.00, RMSEA = 0.00 (90% CI from 0.00 to 0.09), AIC = 5866.66, BIC = 5947.10. The third model also fit our data well: $\chi^2(7) = 6.469$ ($p > 0.05$), CFI = 1.00, TLI = 1.00, RMSEA = 0.00 (90% CI from 0.00 to 0.09), AIC = 6865.33, BIC = 6952.64. The comparison of these two models should be based on the values of AIC (Werner & Schermelleh-Engel, 2011). The value of AIC of the second model was smaller than that of the third model, indicating that the second model fit our data better than the third model. As the first model was nested in the second model, the comparison of these two models should be through the difference in χ^2 with the difference in *df*. If the $\Delta\chi^2$ value is significant, the more complicated model fits the data significantly better; otherwise, both models fit equally well statistically and, therefore, the simpler model should be recommended (Werner & Schermelleh-Engel, 2011). We compared the two models and found that $\Delta\chi^2(3)=9.411$ ($p<0.05$). This suggests that the second alternative model fit our data significantly better than the first one. Therefore, the second model was finally adopted after the comparison,[1] and the standardized beta coefficients of this model were reported in Table 4.

According to this model (Fig. 2 and Table 4), the correlation between decoding and listening comprehension was non-significant when morphological awareness and vocabulary were controlled for as their covariates. Both decoding and listening comprehension significantly contributed to reading comprehension (*standardized β coefficients* were 0.30 and 0.20 respectively, $p<0.05$). Vocabulary measured at Time 1 had strong effects on both decoding and listening comprehension measured at Time 2 (*standardized β coefficients* were 0.71 and 0.75 respectively, $p<0.001$). Morphological awareness measured at Time 1 had a substantial effect on vocabulary (*standardized β coefficient* = 0.68, $p<0.001$), and it also significantly affected decoding measured at Time 2 (*standardized β coefficient* = 0.21, $p<0.05$). In addition, it affected Time 2 listening comprehension fully through the mediation of vocabulary. After considering their indirect effect on reading comprehension through decoding and listening comprehension, morphological awareness still had a unique direct effect on reading comprehension (*standardized β coefficient* = 0.21, $p<0.05$) whereas vocabulary did not.

Discussion

To our knowledge, this study is the first using a longitudinal study design in children learning English as an L2 in their home country to explore how word knowledge contributed to reading comprehension assessed one year later by considering decoding and listening comprehension. The hierarchical regression models showed that word knowledge (i.e., morphological awareness and vocabulary) assessed one year ago explained substantial variance in decoding, listening comprehension, and reading comprehension. We also found that the degree of the contribution of word knowledge may vary as a function of word knowledge level itself: morphological awareness and vocabulary contributed more to decoding, listening and reading comprehension in those who had higher levels of word knowledge. It could be that

[1] Morphological awareness and listening comprehension were observed variables in this model. To check whether the predictive power of these observed variables was underestimated as opposed to latent variables (decoding and vocabulary), we conducted a fourth model. The structure of the fourth model was the same as this model, except that in the fourth model, there was no latent variable, and we used the average score of receptive and expressive vocabulary tasks to indicate the vocabulary score. In a similar vein, we used the average score of word reading accuracy and fluency to indicate the decoding score. We found that the predictive power of morphological awareness and listening comprehension in the two models was similar. In terms of this, we chose this second model, as it resulted in less measurement error for the latent vocabulary and decoding factors.

those who have more word knowledge might depend on morphological awareness and vocabulary to a larger extent to develop decoding, listening comprehension, and reading comprehension.

The SEM results generally supported our hypotheses. Vocabulary assessed one year ago had very strong effects on both decoding and language comprehension, and it contributed to reading comprehension fully through decoding and language comprehension but did not have a unique direct effect on reading comprehension. However, several studies focusing on an L1 and using regression indicated that vocabulary had a small but significant contribution to reading comprehension beyond decoding and listening comprehension (Braze et al., 2007; Tunmer & Chapman, 2012). Ouellette and Beers' (2010) findings showed that after phonological awareness, decoding, and listening comprehension were controlled, vocabulary still had a unique contribution to reading comprehension in Grade 6 students but not in Grade 1 students. Taken together, these findings suggested that vocabulary may have a varying impact on reading comprehension depending on readers' language proficiency level. It could be that at an early stage of learning to read, children develop decoding and listening comprehension skills in L2 on the foundation of their vocabulary size especially when their L2 is quite different from L1 in phonology. Chinese and English are highly contrasted, and most English phonology is novel to native Chinese speakers (Crystal, 1995; Duanmu, 2007). Therefore, Chinese children who are at an early stage of learning English may need to firstly acquire new words that define the phonological forms of English. Based on this, they are able to further develop decoding skills by matching phonological forms with orthographic forms. In addition, children may further develop listening comprehension based on phonology and word meaning. When learners become proficient in reading, and decoding becomes automatic, the reading materials for learners at that time are more difficult and may involve uncommon words; this possibly makes more obvious the unique direct contribution of vocabulary knowledge to reading comprehension in these more advanced readers as previous studies have shown (e.g., Braze et al., 2007; Ouellette & Beers, 2010). However, previous studies used regression and, hence, the effect of vocabulary on decoding and listening comprehension was not considered when investigating whether vocabulary had a unique contribution to reading comprehension. Therefore, future studies using SEM in learners with various language proficiency levels are necessary to explore whether vocabulary has an additional direct contribution to reading comprehension when its indirect contribution through both decoding and listening comprehension is considered.

In addition, we found that morphological awareness assessed one year ago contributed to reading comprehension partially through vocabulary and decoding, and it also had a unique direct effect on reading comprehension. This is consistent with previous findings in L1 speakers and in children who learn English as an L2 in English-speaking countries (Deacon et al., 2014; Kieffer & Lesaux, 2012; Kieffer et al., 2013). Our study extends this finding to Chinese children who learn English as an L2 in their home country. It suggests that morphological awareness contributes to the development of vocabulary and word decoding also at an early stage of learning an L2 in these children. The direct contribution of morphological awareness to reading comprehension found in this study supported Kieffer and Lesaux's

(2012) argument that morphological skills may play multiple roles in reading comprehension. Derivational morphology tested in our study may also contribute to inferring the meaning of unfamiliar words from texts which in turn facilitates the reading comprehension process. However, we found that morphological awareness did not have an additional influence on listening comprehension assessed one year later beyond vocabulary. It could be that the morphological awareness measure we used in this study only tested derivational morphology which did not indicate grammatical information such as the plural form and verb tense. Therefore, future studies involving the tests of more various morphology, such as inflectional and compounding morphology, are needed to test whether word morphology has an additional contribution to listening comprehension beyond vocabulary.

A number of scholars have regarded word knowledge, especially vocabulary, as a subset of language comprehension component in The Simple View of Reading Model (Braze et al., 2016; Perfetti et al., 2005). However, our findings did not support this claim in Chinese children learning English as an L2 at an early stage, as the effect of word knowledge on decoding was very strong and could not be ignored. However, our findings partially echoed the Reading System Framework (Perfetti & Stafura, 2014) and the Lexical Quality Hypothesis (Perfetti & Hart, 2001) by showing that the semantic and phonological aspects of the lexicon, assessed via morphological awareness and vocabulary, affected both language comprehension and word identification in reading comprehension.

This study had practical implications. It implied that morphological awareness and vocabulary are likely to be essential skills of developing decoding, listening comprehension, and reading comprehension at an early stage of learning an L2. Therefore, morphological skills and vocabulary should be emphasized in L2 instruction. Previous studies have shown that explicit training of morphological skills in young children is especially effective in promoting reading comprehension (Arnbak & Elbro, 2000; Lyster et al., 2016), and our findings also supported the importance of morphological awareness in developing decoding and reading comprehension. Therefore, training on morphological awareness appears to be a possible effective way to facilitate young children's learning to read, and we suggested that such training be included in English lessons in Hong Kong.

Although this study had notable theoretical and practical implications, it had limitations. The importance of morphological awareness and vocabulary in decoding, listening comprehension, and reading comprehension in an L2 may vary as a function of L2 proficiency and L1-L2 similarity (e.g., Ouelette & Beers, 2010). Thus, our findings obtained from Chinese children who were at an early stage of learning English may not be generalizable to advanced L2 learners. Future studies are needed to replicate this study in more experienced L2 learners. In addition, we did not control for decoding, listening comprehension, and reading comprehension at the initial level; therefore, our study could not suggest as to whether morphological awareness and vocabulary contributed to the growth of decoding, listening comprehension, and reading comprehension. Moreover, morphological awareness and listening comprehension were respectively tested through one measure only and were observed variables in the SEM, while vocabulary and decoding were indexed by two tests. The mixture of observed and latent variables might affect the relative strength of the relations in the SEM. Multiple measures on one construct are likely to provide a more adequate measure of that construct (Kline, 2015). Thus, future studies with various measures to assess morphological awareness, vocabulary, listening comprehension, and reading comprehension are needed to replicate this study.

Conclusion

This study was conducted in Chinese children learning English as an L2 in a Chinese region by using a longitudinal study design. Morphological awareness and vocabulary assessed one year ago notably explained the variance in decoding, listening comprehension, and reading comprehension. Morphological awareness and vocabulary explained more variance in decoding, listening comprehension, and reading comprehension in children who had higher levels of word knowledge than in those who had lower levels of word knowledge. Vocabulary assessed one year ago contributed to reading comprehension fully and strongly through decoding and listening comprehension. Morphological awareness assessed one year ago contributed to reading comprehension through vocabulary and decoding, and it also had a unique direct contribution to reading comprehension.

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