Abstract

Considering the dual-level representation of meaning in print in Chinese, this study differentiated between morphemic (i.e., morphemic awareness) and sub-morphemic (i.e., graphomorphological awareness) dimensions of morphological awareness and examined their concurrent contributions to text comprehension in fourth grade Chinese readers in a multilingual context where Chinese literacy only has an ancillary function. Structural Equation Modeling analysis revealed that while both dimensions of morphological awareness were significant independent contributors to word reading and vocabulary knowledge, only morphemic awareness significantly predicted text comprehension over and above the two word-level skills. On the other hand, significant indirect effects of both graphomorphological and morphemic awareness were found on text comprehension; in addition, those indirect effects were found to be mediated by vocabulary knowledge or jointly by word reading and vocabulary knowledge. These findings were discussed in light of the centrality of meaning in text comprehension and possible contextual variation in the functioning of different dimensions of morphological awareness in Chinese reading development.

Keywords: morphological awareness, graphomorphological awareness, word reading, vocabulary knowledge, text comprehension

Multidimensionality of Morphological Awareness and Text Comprehension among Young Chinese Readers in a Multilingual Context

1. Introduction

A universal principle holds that print encodes spoken language (i.e., mapping principle) (Perfetti, 2003). Yet, how specifically different language units are mapped onto print (i.e., mapping details) varies from language to language (Ziegler & Goswami, 2005). In researching how reading acquisition across languages may reflect this mapping principle as well as language/script-specific processes in accordance to each language's mapping details, Chinese has been foregrounded as a unique case (Leong, 2015; Perfetti, 2003; Perfetti, Cao, & Booth, 2013). As a morphosyllabic language, Chinese differs from alphabetic languages like English not only in how sounds are encoded in print (i.e., syllable-to-character/morpheme as opposed to phoneme-to-letter mapping), but also its distinctive dual-level representation of meaning in print (i.e., morphemic and sub-morphemic/character) (Kuo & Anderson, 2006; Leong, 2015; Shu & Anderson, 1997; Tong, Tong, & McBride, 2017).

While morphological awareness emerges from early spoken language experiences, it is further shaped by children's print experiences after formal literacy education commences (Kuo & Anderson, 2006). Thus, developmentally in the context of reading acquisition, it would be limiting to examine morphological awareness primarily as an oral language skill without addressing its interface with orthography. In Chinese, the dual-level meaning representation in print means that morphological awareness is at least comprised of two dimensions, one at the morphemic level (e.g., homophone [书 /shū/ *book* and 叔 /shū/ uncle]; homograph [花 /huā/ means *flower* in 花粉/huāfěn/ *pollen* and *spend* in 花费/huāfèi/ *expense*]; and compounding [月光 /yuèguāng/ moonlight]) and the other at the sub-morphemic level, the latter of which pertains specifically to meanings represented by semantic radicals (i.e., a graphomorphological unit; e.g., 氵 denoting *water* or *liquid* as in 河/hé/ *river* and 酒/jiǔ/ *liquor*) (e.g., Leong, 2015; W. Li, Anderson, Nagy, & Zhang, 2002; Shu & Anderson, 1997; Tong et al., 2017). Theoretically, both dimensions should play an important role in reading development in Chinese (Tong et al., 2017).

While studies on native Chinese-speaking children's reading acquisition have generally confirmed the critical import of morphological awareness (e.g., Authors, 2013, 2014; Cheng et al., 2017; Ku & Anderson, 2003; W. Li et al., 2002; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003; Shu, McBride-Chang, Wu, & Liu, 2006; Tong et al., 2017), the focal dimensions examined often varied; and few studies considered the aforementioned dimensions concurrently (see Yeung et al., 2011 and Zhang et al., 2012 for exceptions). In addition, most studies focused on character/word reading rather than text comprehension (Nagy, Carlisle, & Goodwin, 2014; Zhang, Lin, Wei, & Anderson, 2014). An unresolved issue in the literature on morphological contribution to text comprehension, which had a primary focus on English, is whether the contribution is primarily mediated by word reading and/or vocabulary knowledge or whether it could be unique over and above these word-level skills (e.g., Authors, in press; Cheng et al., 2017; Deacon, Kieffer, & Laroche, 2014; Kieffer & Lesaux, 2012). It was therefore an interest of the present study to address this issue further with a focus on Chinese readers.

Another limitation to note about the literature on morphology and Chinese reading, including text comprehension (e.g., Cheng et al., 2017; W. Li et al., 2002; Yeung et al., 2011; Zhang et al., 2012), is that studies largely focused on native Chinese-speaking readers in a context where Chinese is children's primary literacy and there are strong needs and opportunities for literacy practices on a daily basis (e.g., China). This context, however, is not necessarily characteristics of all contexts where students learn to become literate in Chinese. For example, in

Singapore, a multilingual country in Southeast Asia with a bilingual education policy, while Chinese as one of the official languages is learned in school, it only plays an ancillary function in the society. Unlike their peers in China, ethnic Chinese students in Singapore have limited needs for learning and using Chinese, particularly reading and writing. Consequently, it is a question how restricted (oral and) literacy experiences would have an impact on children's morphological insights (especially, graphomorphological insights), and more importantly, the contribution of those insights to reading development. On the one hand, the skills underpinning monolingual Chinese reading may hold for learners in Singapore given the language-to-print mapping properties of Chinese; on the other hand, previous research that compared L1 and L2 readers of alphabetic languages revealed that context could have also an influence on how different sub-skills are specifically orchestrated in the process of becoming literate (Koda, 2005; Lipka & Siegel, 2007; Verhoeven, 2000).

To this end, with a focus on young Chinese readers in Singapore, this study aimed to examine how different dimensions of morphological awareness (i.e., morphemic versus sub-morphemic) might independently contribute to those readers' text comprehension in Chinese, with consideration of possible mediation of word reading and/or vocabulary knowledge.

1.1 Multidimensionality of Morphological Awareness in Chinese

Chinese is a morphosyllabic language that shows syllable-to-character mapping. Specifically, in printed Chinese, each written symbol or character, which is composed of strokes and stoke patterns, represents a syllable, and is typically a morpheme. A Chinese syllable is comprised of an initial and a final or an onset and a rime. A restricted set of onsets and rimes forms about 400 valid syllables in Chinese, and with the four tones considered, there are about 1,300 valid tone syllables (Taylor & Taylor, 2014). Given the large number of characters, homophony is highly pervasive in Chinese. In addition, the meanings of a significant number of Chinese characters vary when those characters appear in different lexical contexts (i.e., homography).

Beyond the difference in how print encodes sound or phonological information, how meaning is encoded in alphabetic languages and Chinese also show notable variations. Chinese is demonstrated to have two levels of meaning representation or morphological structure in print, including morphemic and sub-morphemic levels (Leong, 2015; Shu & Anderson, 1997; Tong et al., 2017). At the sub-morphemic level, sometimes called "subcharacter morphology" (Myers, 2006, p. 170), most Chinese characters (estimated to be about 80% to 90% of all) are compounds composed of two orthographic components named phonetic and (semantic) radical, respectively; these components have varied spatial configurations and canonical positions (e.g., left-right, top-bottom, surrounding, and half-surrounding) (Taylor & Taylor, 2014). While a phonetic provides a clue to the sound of its host character, a radical provides information about the meaning of that character and is added to the phonetic to distinguish the host character from its homophonic neighbors. Phonetics and radicals are often single-unit characters themselves (about 90% for the former and 73% for the latter in elementary school Chinese; see Shu, Chen, Anderson, Wu, & Xuan, 2003). For example, 像 ([person being] *alike*) and 橡 (*oak*) are homophones that share the same right component 象 (/xiàng/, *elephant*) as the phonetic. What distinguishes the two characters is the different radicals: 亻 (人; *indicating person*) for 像 and 木 (*wood*) for 橡. Previous studies revealed that these orthographic units are functional components in character processing (Feldman & Siok, 1999; Taft & Zhu, 1997), and play an important role in Chinese children's reading acquisition (e.g., Anderson, Li, Ku, Shu, & Wu, 2003; Ho & Bryant, 1997).

While many Chinese characters are free morphemes or words themselves, Chinese words are primarily formed through morphological processes, predominantly compounding. In printed

Chinese texts, compound words appear in two or more characters with no space in between (C. Li & Thompson, 1981). For example, 篮球 /lánqiú/ (*basketball*) is a nominal compound with a modifier-head relationship; the two component characters 篮 and 球, which mean *basket* and *ball*, respectively, are both phonetic-semantic compound characters. There is psycholinguistic evidence that in visual processing of two-character compound words, both morphemic (i.e., component characters) and sub-morphemic units (e.g., semantic radicals in component characters) are activated (e.g., Miwa, Libben, & Baayen, 2012).

In accordance to the above properties of dual-level meaning representation or morphological structure in print, morphological awareness in Chinese, in the context of reading acquisition, is logically comprised of two dimensions: one at the morphemic/character level (e.g., concatenation of morphemes through compounding) and the other at the sub-morphemic/character level (i.e., semantic radicals) (Kuo & Anderson, 2006; Tong et al., 2017). In the present study, the former dimension is referred to as morphemic awareness, and the latter as graphomorphological awareness recognizing that this dimension is distinctively about an orthographic unit that is meaningful within a character/morpheme.

1.2 Morphological Awareness and Chinese Reading

Given the aforementioned properties of Chinese morphology, it is unsurprising that a significant number of studies on Chinese-speaking children revealed that both morphemic and graphomorphological awareness are significant predictors of word reading and vocabulary knowledge. For example, morphemic awareness, such as homophone and homograph discrimination and compound construction, was found to contribute to character as well as multi-character word reading, over and above phonological awareness (e.g., Chen, Hao, Geva, Zhu, & Shu, 2009; H. Li, Shu, McBride-Chang, Liu, & Peng, 2012; Liu & McBride-Chang, 2010; Liu, McBride-Chang, Wong, Shu, & Wong, 2013; McBride-Chang et al., 2003; Shu et al., 2006; Tong et al., 2017; Yeung, Ho, Wong et al., 2013). Compound awareness was also found to be a significant predictor of vocabulary knowledge (e.g., Chen et al., 2009; Liu et al., 2013; Liu & McBride-Chang, 2010; McBride-Chang et al., 2005; H. Zhang, 2015). In addition, awareness of semantic radicals was a significant correlate of word reading (e.g., Ho, Wong, & Chan, 1999; Tong et al., 2017; Zhang et al., 2012); and instruction on the orthographic structure of characters, including semantic radicals, led to significant improvements in children's ability to read and write characters (e.g., Packard et al., 2006; Wu et al., 2009). Radical awareness was also found to enable children to infer meanings of unfamiliar characters (e.g., Shu, Anderson, & Zhang, 1995), and consequently, facilitate their vocabulary growth (Tong et al., 2017).

Despite the contribution documented separately for morphemic and graphomorphological awareness, little research, however, examined the effects of both dimensions concurrently. In a study that aimed to fill this research gap, Tong et al. (2017) compared the relative contributions of sublexical-level (i.e., graphomorphological) and lexical-level (i.e., morphemic) morphological awareness in Hong Kong second graders' word reading. The former dimension was measured with a task in which children were asked to choose a picture that could best represent the meaning of a pseudo-character (based on the semantic information of the radical of the character). The latter dimension was measured with a compound word construction task. After controlling for each other's effect (and the effects of other related skills), sublexical-level morphological awareness, as opposed to the lexical-level type, significantly predicted word reading. Tong et al. (2017), however, did not address how the two dimensions of morphological awareness would respectively contribute to text comprehension.

Recently there have been increasing interests in possible functional relationships between morphological awareness and text comprehension in Chinese (and other languages as well), in particular, if the former is a unique predictor of the latter (e.g., Authors, 2014; Cheng et al., 2017; Ku & Anderson, 2003; Pan et al., 2016; Shu et al., 2006; Yeung et al., 2011; Yeung, Ho, Chan et al., 2013; H. Zhang, 2016; J. Zhang et al., 2012). Theoretically, morphological contribution to text comprehension could be partly understood from the perspective of the Lexical Quality Hypothesis (Perfetti, 2007), which contends that high quality representation of words, including their orthographic, phonological, grammatical, and semantic features, leads to efficient retrieval of those words during textual reading, and subsequently, successful comprehension. Inasmuch as "knowledge of how oral and written morphology work in a given language could be understood as a binding agent that pulls together these individual features of lexical representation to enhance lexical quality" (Bowers, Kirby, & Deacon, 2010, p. 168), greater morphological awareness would suggest easier and more rapid decoding of words and access to their meanings. In addition, stronger morphological awareness would also mean that learners are better able to enlarge their vocabulary through lexical inferencing or morphological problem solving (Anglin, 1993; Authors, 2012; Carlisle, 2007; Liu et al., 2013; Nagy et al., 2014). Given the close relationship of efficient word decoding and vocabulary knowledge to comprehension, "the golden triangle of reading skill" (Perfetti, 2010), morphological awareness would presumably contribute to text comprehension indirectly through its shared relationship with the two word-level skills. Such indirect effects have recently been tested in English readers with varied findings (e.g., Authors, in press; Deacon et al., 2014; Kieffer & Lesaux, 2012); few studies, however, seemed to have addressed them in Chinese readers (see Cheng et al., 2017 for an exception).

On the other hand, the importance of morphology for text comprehension may go beyond lexical mediation. Discussing the role of morphology in Chinese reading, Zhang and colleagues (2014) contended that the capacity and efficiency of working memory may be enhanced by morphological awareness in that sensitivity to the morphological structure of words, among other functions, could "increase the size of chunks, decrease the number of complexity of chunks held in verbal working memory." (p. 14) (see also Nagy et al., 2014). In line with such reasoning, learners with strong morphological awareness (and thus a more enhanced working memory) would be able to free some working memory resources to participate in high-level processes of text comprehension. Strong morphological awareness may also inhibit insensible morphological combinations that may be incurred due to the lack of word boundaries in printed Chinese texts (Zhang et al., 2014). Finally, morphology, in addition to helping strengthen the representation of word meanings (Sandra, 1994), is often a reliable strategy that learners can use to unlock meanings of unknown words in textual reading (e.g., Authors, 2012, 2013, 2016; Carlisle, 2007; Nagy et al., 2014). The affordance of morphological awareness for "on-the-spot vocabulary learning" (Nagy, 2007, p. 64) or instantaneous resolution of lexical gaps thus plays a strategic role in textual reading.

Empirically, the small number of studies only generated limited insights about the relationships of morphological awareness with text comprehension in Chinese because in their modeling of the relationships, there was often a lack of consistent considerations of word decoding and vocabulary knowledge, two significant correlates of morphological awareness as reviewed earlier. In most cases, the modeling only considered word decoding (e.g., Cheng et al., 2017; Pan et al., 2016; Yeung et al., 2011; Yeung, Ho, Chan et al., 2013) or vocabulary knowledge (e.g., Ku & Anderson, 2003; Shu et al., 2006; H. Zhang, 2016); sometimes, neither was considered (e.g., W. Li et al., 2002). Without considering both word-level skills, any identified mediated effect, or the lack thereof, would not accurately represent the complex relationships of morphological awareness with text comprehension (e.g., Cheng et al., 2017; Yeung, Ho, Chan et al., 2013; H. Zhang, 2016).

In a longitudinal study on 7-year old Chinese-speaking children in Hong Kong, Zhang and others (2012) found that Chinese character recognition as opposed to vocabulary knowledge, and morphemic awareness (or morphological awareness as it was called in that study) as opposed to graphomorphological awareness (orthography-semantic awareness) were significant, unique predictors of reading comprehension. A year later, however, while the pattern of the two lexical skills remained, a converse pattern was found of the two types of morphological skills. Interestingly, after character recognition was taken away from the regression equations, vocabulary knowledge surfaced consistently as a significant predictor of reading comprehension. In addition to the interesting patterns about the contributions of morphemic and sub-morphemic skills to Chinese reading, which may vary developmentally, the study also appeared to lend support for the importance of concurrent consideration of both word reading and vocabulary knowledge in examining how (different dimensions of) morphological awareness contributes to reading comprehension. Unfortunately, the study did not test possible indirect effects of morphological awareness on reading comprehension through the mediation of character reading and/or vocabulary knowledge. In addition, the reading comprehension task seemed to focus on sentence rather than text comprehension, and appeared to be lexically simple. This might be a reason that the contribution often revealed of vocabulary knowledge to reading comprehension did not surface in the study (when other variables were considered).

1.3 The Present Study

Little research has examined the concurrent contributions of morphemic and graphomorphological awareness to Chinese text comprehension. In addition, it has been unclear how morphological awareness specifically contributes to text comprehension. Finally, what is known about the developmental role of morphology in Chinese reading was largely derived from studies on monolingual children. While the requisite skills for Chinese reading may be the same disregarding who the learners are because of the language-to-print mapping and textual properties of Chinese, context may also have a strong influence on how those skills are orchestrated or prioritized in the process of becoming literate, as suggested by previous research on alphabetic readers (Koda, 2005; Lipka & Siegel, 2007; Nassaji, 2014; Verhoeven, 2000).

To this end, the present study focused on young Chinese readers in Singapore where students learn to become biliterate in English and their ethnic language, but English is their primary literacy and ethnic language literacy only has an ancillary function in the society. Specially, it aimed to answer the following two questions.

1. Are morphemic and graphomorphological awareness independent contributors to Chinese text comprehension over and above word reading and vocabulary knowledge? Based on the previous discussion about the function of morpheme-level awareness (e.g., inhibiting insensible morphological combinations during text reading in Chinese; see Zhang et al., 2014), it was predicted that morphemic awareness would make a significant, independent contribution to text comprehension; on the other hand, given children's restricted print experiences in Chinese, a similar effect of graphomorphological awareness would not surface for text comprehension, although it could be significant for word reading given the properties of Chinese characters.

2. Do the two types of morphological awareness have indirect effects on text comprehension through the mediation of the two word-level skills? Given the role of

morphology as “a binding agent” for individual features of lexical representation (Bowers et al., 2010, p. 168) and Perfetti’s (2010) claim on the relationships of lexical skills with text comprehension (i.e., “the golden triangle of reading skill”), it was predicted that the indirect effects morphological awareness on text comprehension would be significant.

2. Method

2.1 Participants

The participants were 265 fourth graders in Singapore. Human subjects approval was received from Nanyang Technological University Institutional Review Board. Consent was obtained from the students’ parent/guardian, and assent from the students themselves. Other human subjects guidelines were also strictly followed. The students were all ethnic Chinese, and included 151 boys and 114 girls with an average age of about 10.4 (*SD* = .38). A multilingual country in Southeast Asia, Singapore has a population of about 5.5 million that is comprised of three major ethnic groups, including Chinese, Malay, and Indian, with the Chinese being the largest group (Department of Statistics, 2015). It has four official languages, including the three ethnic languages of those three groups (i.e., Chinese, Malay, and Tamil) and English. Singapore has adopted an English-knowing bilingual education policy in which all students learn English, which is also the medium of instruction, as well as a respective ethnic language. Formal schooling begins with the first grade in primary school from which time all children are taught to become literate in English and ethnic language for 12 years until the end of junior college (or high school). While bilingualism is the cornerstone of the educational system in Singapore, English is the *de facto* societal language with broader significance for trans-ethnic communication and plays a predominant role in the social and professional life of Singaporeans, whereas ethnic language and literacy only perform an ancillary function, such as maintenance of cultural heritage.

The linguistic profiles of Singaporean families and students are becoming increasingly diverse and complex due to the graduate shift of home language from ethnic language toward English over the past decades. The diversity and complexity was also reflected in the patterns of home language use among the participants of the present study. While the parents of many of the participants reported both using either Chinese ($N = 72$) or English ($N = 45$) as their dominant home language, a larger number of others reported diverse patterns of bilingual use of the two languages at home (e.g., balanced use by both parents or one parent using Chinese or English and the other parent using the other language as the dominant language). Those students were thus essentially bilingual and biliteracy learners, although for the purpose of this study, the focus was only on their Chinese reading.

Compared to their Chinese-speaking counterparts in China, those children had very limited needs and opportunities for Chinese literacy practices. For example, the Chinese Language Syllabus (Primary) (Singapore Ministry of Education, 2014) has a requirement of only 4–7 hours of Chinese lessons every week (roughly about an hour a day). The rest of school instruction is on or conducted in English. Because of the increasing challenges perceived of students learning to read and write in Chinese (concurrently with English), the Chinese language curriculum has also been constantly adjusted to lower the benchmarks for literacy. To use that for characters as an example, the Chinese Language Syllabus (Primary) indicates that third and fourth graders be able to recognize 1,200-1,300 characters and write 700-750 of those characters, which is far below the level required of their peers in China (2,500 and 2,000, respectively, for recognition and writing) (Chinese Ministry of Education, 2011).

2.2 Measures

The following tasks were administered at the end of the children's Grade 4 year. In addition, Raven's Standard Progressive Matrices (Raven, Raven, & Court, 1998; Sets A, B, and C with 36 items) were also administered to measure their non-verbal intelligence. Following the practice of earlier studies (e.g., Tong et al., 2017; Yeung et al., 2011), it was included as a covariate to help obtain a refined relationship of morphological awareness to reading comprehension, given the shared variance often documented of intelligence with reading and its sub-skills. Except the phonological awareness and word reading tasks, which were individually administered in a quiet space in children's schools, all tasks were group administered in their regular Chinese classes. The reliability (Cronbach's α) of all the literacy measures are presented in Table 1 together with the means and standard deviations of children's performance.

2.2.1 Phonological awareness

Phonological awareness was measured with an Onset Deletion task and a Tone Discrimination task. For the Onset Deletion task, children were presented 15 syllables (e.g., /zǎi/) and were asked to say aloud the rest of each syllable or the rime (i.e., /ǎi/) without the onset (i.e., /z/). The Tone Discrimination task presented children with 12 groups of three syllables, two of which had the same tone (e.g., /kě/ and /lěng/); children were asked to identify the third syllable that had a different tone (e.g., /jiàn/).

2.2.2 Morphemic awareness

Morphemic awareness was measured with three tasks, including a Morpheme Discrimination task, a Compound Structure task, and a Meaning Selection task. All tasks were read aloud to children as they worked on paper versions of the tasks. The Morpheme Discrimination task, which was based on a similar task in Ku and Anderson (2003), tested whether children understood that a character may have different meanings in different words. Children were presented 14 groups of three two-character words that shared a character (e.g., 商), and for each group, they were asked to identify the word where the meaning of the shared character (e.g., 商量 /*discuss* where 商 means *discuss* or *consult*) was different from that in the other two words (e.g., 商业/*business* and 商品/*product* where 商 means *commerc*e).

The Compound Structure task, designed with reference to similar tasks in Wang, Cheng, and Chen (2006) and Chen and colleagues (2009), measured children's understanding of the modifier-head structure of Chinese nominal compounds. Children were asked to choose a two-character compound that better answered a riddle, for example, 长在树上的花叫什么更好: 树花还是花树? (*Which is a better name for the flower that grows in a tree: a tree flower or a flower tree?*). Its paired version was 只长花的树叫什么更好: 花树还是树花? (*Which is a better name for the tree that grows a flower: a tree flower or a flower tree?*). Following Wang and others (2006) and D. Zhang (2013), more complex riddles involving three-character compounds were also included. The task consisted of 20 items with seven pairs of two-character compounds and three pairs of three-character compounds.

The Meaning Selection task was modelled on a similar task in Ku and Anderson (2003). It consisted of 20 two-character compounds that were judged as unfamiliar to the participants by their Chinese teachers. Each target word was relatively low in frequency with high-frequency component characters, such as 病员 (literally, *sick-person*; *patient*), and was followed by four lexically and grammatically simple meaning interpretations. Children were asked to select the one interpretation that best represented the meaning of the target word.

2.2.3 Graphomorphological awareness

Graphomorphological awareness was measured with three tasks that all pertained to semantic radicals, including a Radical Discrimination task, a Radical Identification task, and a Radical Meaning task. For the Radical Discrimination task, children were presented with 20 pairs of two-character words where in each pair, one word was correct (i.e., the focal character having the correct semantic radical) and should thus be circled (e.g., 电脑), whereas the other had a character with the wrong radical (e.g., 电恼).

The Radical Identification task included 10 phonetic-semantic compound characters, each of which (e.g., 飘) was followed by four orthographic components (e.g., 示, 票, 风, 西) with only one being the semantic radical (i.e., 风). Children were supposed to identify 风 as the component that was related to the host character in meaning.

The Radical Meaning task was modelled on a similar task in W. Li and others (2002) and included 10 two-character compound words, each of which had the pinyin of the characters available together with an English meaning explanation; one of the component characters, however, was missing (e.g., __毛 jíemáo / *eyelash*). Children were asked to fill in the blank with a character from four given choices that shared the phonetic component but had different semantic radicals (e.g., 婕, 睫, 捷, 倢). Pinyin and English translation were intended to provide students with access to the meaning of the word so that the character with the correct radical could be discerned. This task did not require children to actually know the choice characters to select 睫 as the answer, as long as they knew that 睫 had 目, which means *eye*, as the meaningful sub-character component.

2.2.4 Word reading

Chinese word reading was measured with two decoding tasks that focused on single characters and multi-character words, respectively. All characters and words were sampled from the

Chinese textbooks for primary school students developed by the Singapore Ministry of Education. They included easier ones selected from the textbooks that had been learned by the children and more difficult ones from those that had not been taught. The Character Reading task included 20 single characters; the Word Reading task included 20 multi-character compound words. Children were asked to read aloud those characters and words printed on cards. To receive a point, a character (or both/all component characters in the case of multi-character words), including its tone, needed to be named correctly.

2.2.5 Vocabulary knowledge

Oral vocabulary knowledge was measured with a picture selection task developed after the form of the PPVT-IV (Dunn & Dunn, 2007). It included five sets of 12 multi-syllabic words of various frequency levels based on the *Modern Chinese Frequency Dictionary* (Beijing Language Institute, 1986). Each word was followed by four pictures drawn by an artist. Children were asked to listen to the 60 words read aloud to them, and then indicate on an answer sheet the number of the picture that best represented the meaning of each word.

2.2.6 Text Comprehension

Text comprehension was measured with a multiple-choice passage comprehension task, which included one narrative and two informational passages with a mean length of about 350 characters. Each passage was followed by five multiple-choice questions that tested different aspects of comprehension skills (with a total of 15 questions). The first question (Word Selection) asked children to select a word to fill a blank in a passage. All choice words were simple and plausible collocates of the adjacent word. Comprehension, at least local meanings, was thus required for children to select the correct word. The second question (Sentence Selection) was similar to the first one in format but asked children to select a sentence or clause to fill a blank. The third question (Co-Reference) focused on co-referential relationships, asking children, for example, to select a choice to indicate the referent of a pronoun. The fourth question (Textual Inference) tested inferential comprehension. The last one (Gist) asked children to select a statement that best summarized the main idea of a passage.

2.3 Data Analysis Methods

Structural Equation Modeling (SEM) (Kline, 2016) was adopted to model the relationships of morphemic and graphomorphological awareness with text comprehension. Both direct (over and above word reading and vocabulary knowledge) and indirect effects (through the mediation of the two word-level skills) of the two dimensions of morphological awareness were tested. A conceptual model (see Figure 1) was constructed where in the measurement part, the previously described tasks that measured each literacy ability were hypothesized to load on their respective latent variable except Vocabulary Knowledge, which had only one indicator. In the structural model, Phonological Awareness, Morphemic Awareness, and Graphomorphological Awareness factors, which were allowed to covary, were hypothesized to predict Word Reading, Vocabulary Knowledge, as well as Text Comprehension (Nagy et al., 2014). Word Reading and Vocabulary Knowledge were hypothesized to predict Text Comprehension, given the lexical basis of reading comprehension (Perfetti & Hart, 2001). Following Perfetti's (2010) conceptualization of the linchpin role of vocabulary knowledge in the Decoding-Vocabulary-Comprehension or DVC triangle of reading skill, which suggests that decoding would need to go through word meanings or vocabulary knowledge to have an impact on text comprehension, a path was also hypothesized from Word Reading to Vocabulary Knowledge. Finally, nonverbal intelligence was hypothesized to predict all the latent and non-latent variables in the structural model.

Insert Figure 1 about here

The above SEM model was tested on M*plus* 7 (Muthén & Muthén, 1998-2015) with Maximum Likelihood (ML) estimation. Following Hu and Bentler (1999), this study used Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Mean Square Residual (SRMR) for the evaluation of model fits. Cutoff values of CFI ≥ .95, RMSEA ≤ .06, or SRMR ≤ .08 indicated an SEM model with very good fits.

3. Results

3.1 Descriptive Statistics and Bivariate Correlations

Table 1 shows the means and standard deviations of all the measures. Table 2 shows their correlations. To highlight, all tasks that measured morphemic and graphomorphological awareness significantly correlated with both character and compound word decoding, vocabulary knowledge, as well as all five sub-skills measured for text comprehension. In addition, both decoding measures and vocabulary knowledge significantly correlated with text comprehension.

Insert Tables 1 and 2 about here

3.2 Structure Equation Modeling Analysis

The SEM model shown in Figure 1 was found to have very good model fits: χ^2 (100) = 155.136, $p < .001$, CFI = .978, SRMR = .031, and RMSEA = .046 (CI: .031, .059). The factor loadings of the indicators were all significant for each latent variable (*p*s < .001). Table 3 shows the parameter estimates for the structural part of the SEM model (i.e., path coefficients and covariances). Figure 2 provides a graphic representation of the model with significant structural parameters added. As shown in Table 3, Phonological Awareness, Graphomorphological Awareness, and Morphemic Awareness all significantly covaried. Both types of morphological awareness were significant, unique predictors of Word Reading, β = .496 and β = .463 for Graphomorphological and Morphemic Awareness, respectively (both *p*s < .001). Over and above Word Reading and other predictors, they also made significant, independent contributions to Vocabulary Knowledge, β = .370, p < .001 and β = .235, p = .003 for Graphomorphological and Morphemic Awareness, respectively. After controlling for Word Reading, Vocabulary Knowledge, and Graphomorphological Awareness, Morphemic Awareness made a significant, unique contribution to Text Comprehension (β = .485, p < .001); over and above the two word-level skills and Morphemic Awareness, a significant effect of Graphomorphological Awareness, however, did not surface (β = .172, p = .107). Altogether, the predictors explained about 86.9% of the variance of Text Comprehension (p < .001).

Insert Table 3 and Figure 2 about here

As shown in Figure 2, both Graphomorphological and Morphemic Awareness also indirectly influence Text Comprehension through three possible paths: the first through Word Reading; the second Vocabulary Knowledge; and the last both word-level skills. As Table 4 shows, the total indirect effects were significant for both types of morphological awareness. A closer examination of the component indirect effects, however, revealed some interesting patterns with Word Reading and Vocabulary Knowledge as mediators. Specifically, the indirect path through Vocabulary Knowledge alone, as opposed to Word Reading alone, was significant for both Graphomorphological and Morphemic Awareness; in addition, the indirect effects through the joint mediations of the two lexical skills were marginally significant.

4. Discussion

This study examined how different dimensions of Chinese morphological awareness contributed to text comprehension, focusing on young readers learning to become literate in Chinese in a multilingual context with restricted literacy experiences. While both morphemic and graphomorphological awareness were significant, independent predictors of word reading and vocabulary knowledge, which corroborate the previous findings on monolingual Chinese-speaking children (e.g., H. Li et al., 2012; Liu & McBride-Chang, 2013; McBride-Chang et al., 2003, 2005; Shu et al., 2006; Tong et al., 2017; Yeung et al., 2011), only morphemic awareness, as predicted, significantly predicted text comprehension after accounting for the effects of word reading and vocabulary knowledge. On the other hand, both types of morphological awareness contributed indirectly to text comprehension significantly, and vocabulary knowledge was found to play a pivotal mediation role for the indirect effects.

4.1 Unique Effects of Morphological Awareness on Text Comprehension

The significant effect of morphemic awareness on text comprehension over and above word reading and vocabulary knowledge was reasonable, given that there are, theoretically, aspects of morphological insights that could be uniquely important for textual reading, as discussed earlier in this paper. To highlight, compound awareness, which was the focus of the Compound Structure task, might have helped the learners discriminate word boundaries in printed texts where there is no space between words (Zhang et al., 2014). The Meaning Selection task in the battery of morphemic awareness tasks could be another reason for the significant unique effect. As noted earlier, morphological strategy is a reliable resource that learners can draw upon to resolve some lexical gaps during textual reading through their attention to intra-word morphological properties of unfamiliar words and lexical inferencing (Authors, 2012, 2013, 2016; Nagy, 2007; Nagy et al., 2014). Such instantaneous resolution of vocabulary gaps logically facilitates text comprehension beyond learners' actual repertoire of vocabulary knowledge.

A significant unique effect of graphomorphological awareness on text comprehension, however, did not surface. Because semantic radicals encode meaning, and radical awareness facilitates the learning of new characters (e.g., Shu et al., 1995), it might be reasonably expected that graphomorphological awareness could also help learners address some character/lexical gaps during textual reading, and consequently, would emerge as a unique predictor of text comprehension as well. The finding may reflect a pattern specific to reading development among the participants in this study. As indicated earlier, students in Singapore, compared to their peers in China, have limited needs and opportunities for literacy practices in Chinese, particularly writing, because Chinese only has an ancillary function in the society (e.g., maintenance of cultural heritage). Given that refined orthographic representations in Chinese largely depend on high-quality print exposure and practice, notably writing (Guan, Liu, Chan, Ye, & Perfetti, 2011; Perfetti, Cao, & Booth, 2013), it would also seem reasonable that as a result of children's restricted literacy experiences in Chinese, graphomorphological awareness failed to emerge as a significant predictor for higher-level reading skills like text comprehension, even though its effect was significant for word reading given the properties of Chinese characters.

On the other hand, it is speculated that the finding might also be a result of semantic radicals providing only partial, and sometimes unreliable, meaning information about their host characters (and thus, a limited rate of success for inferring meanings of unknown characters in a text). For example, the 钅 (金) radical, which refers to metal materials (e.g., 铁/*iron*) or an action related to metal (e.g., 铸/*to cast metals*), does not carry this meaning at all in 错, which means *wrong* or *error*. Thus, semantic information in radicals often would need to be combined with contextual clues for reliable inference of the meanings of unknown characters (e.g., Ku & Anderson, 2001; Mori & Nagy, 1999; Shu et al., 1995). In this respect, while the ability to discriminate radicals and the knowledge of radical meanings reasonably played a significant role in character identification, such as found in this study (see Figure 2) and in previous studies on native Chinese-speaking children (e.g., Ho & Bryant, 1997; W. Li et al., 2012; Tong et al., 2017), they might not contribute to reading comprehension uniquely over and above character and word reading. In addition, from the perspective of morphological productivity, morphemic units are more productive in yielding new words (e.g., compounding) than graphomorphological units in yielding new characters. Finally, compared to morphemic awareness, which had a focus on compounding in the present study and thus might be facilitated by corresponding insights from English or children's primary literacy (see Wang et al., 2006), graphomorphological awareness tapped a Chinese script-specific aspect of morphological awareness, which might also explain the discrepancy of effects found between the two dimensions of morphological awareness in this study.

The above reasoning, however, would need to be interpreted with caution as to mean that graphomorphological awareness is unimportant for text comprehension among Chinese readers in Singapore or similar contexts where high-quality literacy experiences are unavailable. Because the current study only focused on a particular grade level (i.e., Grade 4), it is unknown whether developmentally a significant effect would emerge later. In their longitudinal study on 7-year-old Chinese-speaking students in Hong Kong, Zhang et al. (2012) found that, while graphomorphological awareness (orthography-semantic awareness) was not a unique, significant predictor of reading comprehension when morphemic awareness, character reading, and vocabulary knowledge were all controlled for, a significant effect did surface a year later. Thus, without a direct comparison with native Chinese-speaking children and tracking literacy development longitudinally, it would be unclear whether the current finding reflects a transient pattern developmentally and/or represents contextual variation. This issue is revisited later when the limitations of this study are noted.

4.2 Indirect Effects of Morphological Awareness on Text Comprehension

The significant (total) indirect effects of both graphomorphological and morphemic awareness on text comprehension can be explained by their close relationships with word reading and vocabulary knowledge (see Figure 2). It is noted, however, that only the paths that involved vocabulary knowledge, including the more complex one that involved both word reading and vocabulary knowledge, were significant (see Table 4). On the one hand, this finding seems to reinforce the pivotal role of vocabulary knowledge as conceptualized by Perfetti in his "golden triangle of reading skill" (i.e., the DVC model) (Perfetti, 2010); on the other hand, it may suggest that basic decoding accuracy, which was the focus of the word reading tasks in the present study, might be of limited importance to text comprehension for those fourth graders who had formally learned Chinese literacy for four years. In this regard, the finding appeared to corroborate those of a few earlier studies on fourth or fifth grade minority students learning English as a Second Language (ESL) for whom basic decoding accuracy did not significantly predicted reading comprehension controlling for morphological awareness and vocabulary knowledge (e.g., Goodwin, Huggins, Carlo, 2August, & Calderon, 2013; Kieffer & Lesaux, 2008).

In a recent study on young Chinese-speaking children in China, Cheng and others (2017) found that compound awareness actually had a significant indirect effect on reading comprehension through the mediation of word reading. A reason for the presence of that effect, as opposed to the lack of it in the present study (and earlier studies on older ESL learners), might be that Cheng et al.'s (2017) word reading measures considered both decoding accuracy and fluency. Thus, if the word reading tasks in the present study had addressed decoding fluency over and beyond basic accuracy, the indirect effects of morphological awareness mediated by word reading might have been significant. On the one hand, those findings, taken together, seem to suggest that the nature of word reading tasks may matter in the examination of the (indirect) effect of morphological awareness on text comprehension; on the other hand, they seem to confirm that as children progress in their reading development (e.g., from early to late elementary grades), word decoding fluency (and word meanings) rather than basic decoding accuracy begin to function as a stronger predictor of text comprehension (NICHD, 2000). This reasoning also seems to make explainable the significant effect of character recognition on reading comprehension over and beyond morphological awareness and vocabulary knowledge in Zhang et al.'s (2012) study, which focused on early Chinese-speaking readers.

Pedagogically, the pivotal mediation role of vocabulary knowledge suggests that morphological teaching, if the ultimate purpose is to improve students' text comprehension, will need to have a strong meaning focus, particularly learners' ability to work strategically with words for meaning inferencing and construction (Carlisle, 2007, 2010; Nagy et al., 2014). While many previous morphology-focused interventions found significant effects of learning for word reading (see the meta-analysis or synthesis in Bowers et al., 2010; Carlisle, 2010), the effects for reading comprehension were unclear, which might be related to whether or not "morphological problem solving" was included as a core component of the interventions (Anglin, 1993). The centrality of vocabulary knowledge revealed in the present study on fourth graders suggests that at the later stage of elementary schooling or when readers transition from learning to read to reading to learn, meaning-focused morphological instruction should play a particularly important role in facilitating text comprehension development. This implication also seems to align with the well-known "fourth grade slump" among poor readers (Chall & Jacobs, 2003), for which poor vocabulary knowledge is often a critical factor (Kieffer & Lesaux, 2007; Nagy, 2007).

4.3 Limitations and Future Research

A few limitations of this study are noted. The first one, which was noted in earlier discussion, is that the word decoding tasks did not consider fluency, which might have obscured possible indirect effects of morphemic and/or graphomorphological awareness on text comprehension through the mediation of word reading.

The second limitation is that only one group of learners at a particular stage of learning (i.e., Grade 4) was examined. Thus, some findings, particularly those of the relative contributions of graphomorphological and morphemic awareness, remain to be further tested on younger or older learners, preferably in a longitudinal study. In addition, while all the children were ethnic Chinese and learning to become literate in Chinese (and English) in the same schools, their diverse home language backgrounds suggested that different sub-groups might show different relational patterns. Because of the complexity of the SEM model tested and the small size of each sub-group, separate analyses were not conducted. In addition, we did not include native Chinese-speaking students from societies where Chinese is the dominant literacy for comparisons with those Singaporean students. As noted earlier, because of the lack of a comparison group through a longitudinal design, it was unclear whether some findings, such as the lack of a significant effect of graphomorphological awareness on text comprehension, were developmentally transient patterns and/or reflected contextual variations in the orchestration of skills in becoming literate. Future research is needed in this line.

In addition, according to Stanovich's (1980) interactive-compensatory model, the text comprehension performance of the readers in the present study could be the result of their strategic or compensatory use of diverse skills, including morphological awareness, word reading, and vocabulary knowledge. Thus, in the present study, poor decoders with fairly developed oral vocabulary, compared to good decoders, might tend to show a stronger effect of vocabulary knowledge, and thus a stronger indirect effect of morphological awareness (particularly morphemic awareness) through vocabulary knowledge, on text comprehension. This hypothetical interaction of word decoding and/or vocabulary knowledge with morphological awareness in influencing text comprehension, which is referred to as the mediator also being a moderator by Baron and Kenny (1986), warrants testing in future research.

Finally, we did not include a measure on "general" orthographic processing in Chinese that does not necessarily involve meaning. Because of the interest of the present study, the graphomorphological awareness tasks focused on orthography-meaning interface (i.e., semantic radicals); thus, a question remains as to whether any effect of this dimension of morphological awareness (e.g., on word reading) reflected that of general orthographic processing skills or a morphological skill primarily concerning the encoding of meaning in orthography. Additionally, including visual processing skills that do not specifically pertain to Chinese orthography (e.g., Liu, Chen, & Chung, 2015; Luo, Chen, Deacon, Zhang, & Yin, 2013) may help generate even better insights into the functional role of graphomorphological awareness in Chinese reading acquisition. Besides, the Radical Discrimination task, a graphomorphological awareness measure, tested children's radical awareness in the context of two-character words, which might have involved their morphemic-level awareness.

5. Conclusions

Based on the dual-level representation of meaning or morphological structure in print in Chinese, this study differentiated between morphemic (i.e., morphemic awareness) and sub-morphemic (i.e., graphomorphological awareness) dimensions of morphological awareness and examined their concurrent contributions to text comprehension in fourth grade Chinese readers in a multilingual context. SEM analysis revealed that while both dimensions of morphological awareness were independent contributors to word reading and vocabulary knowledge, only morphemic awareness significantly and uniquely predicted text comprehension over and above the two word-level skills. On the other hand, significant indirect effects on text comprehension were found for both graphomorphological and morphemic awareness. Those indirect effects were mediated by vocabulary knowledge and jointly by word reading and vocabulary knowledge but not by word reading alone, which highlighted the centrality of word meanings in text comprehension.

This study enriches our understanding about how morphological awareness contributes to text comprehension, which was often not rigorous tested with multiple dimensions of morphological awareness and possible mediational effects of word-level skills considered. On the one hand, the findings, which were based on young bilingual readers for whom Chinese was not their primary literacy, showed some convergence with those of previous studies on monolingual Chinese-speaking children (e.g., morphemic-level or compound awareness), suggesting a possibly universal role of morphology in reading development in Chinese in accordance to its language-to-print mapping properties; on the other hand, the lack of a direct effect of graphomorphological awareness and indirect effects of both dimensions of morphological awareness on text comprehension through word reading may indicate contextual variations in Chinese reading, which deserves attention in future research.

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Table 1.
Descriptive Statistics, Task Reliability, and Bivariate Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Raven	—																	
Phonological Awareness																			
2	OnsDel	.152*	—																
3	TonDis	.240***	.385***	—															
Graphomorphological Awareness																			
4	RadDis	.217***	.123*	.278***	—														
5	RadIde	.267**	.118	.225***	.510***	—													
6	RadMea	.245***	.125*	.332***	.661***	.575***	—												
Morphemic Awareness																			
7	MorDis	.270***	.225***	.311***	.446***	.452***	.548***	—											
8	ComStr	.232***	.063	.086	.360***	.322***	.423***	.518***	—										
9	MeaSel	.253***	.144*	.297***	.441***	.458***	.449***	.676***	.627***	—									
Word Reading																			
10	ChaRea	.243***	.204***	.330***	.572***	.515***	.698***	.684***	.481***	.624***	—								
11	WorRea	.252***	.167**	.323***	.590***	.558***	.689***	.678***	.485***	.659***	.923***	—							
Vocabulary Knowledge																			
12	Vocab	.200***	.086	.295***	.557***	.502***	.690***	.592***	.479***	.627***	.732***	.778***	—						
Text Comprehension																			
13	WorSel	.175**	.121*	.295***	.404***	.375***	.508***	.518***	.426***	.523***	.577***	.584***	.575***	—					
14	SenSel	.183**	.092	.157*	.355***	.461***	.418***	.451***	.403***	.487***	.511***	.565***	.544***	.468***	—				
15	CoRef	.208***	.168**	.256***	.470***	.476***	.445***	.491***	.476***	.537***	.544***	.584***	.549***	.517***	.459***	—			
16	TexInf	.133*	.101	.199***	.293***	.370***	.412***	.413***	.321***	.441***	.447***	.481***	.482***	.422***	.450***	.391***	—		
17	Gist	-.014	.038	.141*	.332***	.309***	.351***	.401***	.244***	.357***	.384***	.458***	.442***	.318***	.315***	.286***	.284***	—	
18	Total	.192**	.145*	.292***	.518***	.556***	.596***	.635***	.522***	.655***	.688***	.747***	.724***	.762***	.755***	.738***	.709***	.616***	—
n		36	15	12	20	10	10	14	20	20	20	20	60	3	3	3	3	3	15
Mean		28.24	13.06	7.27	16.37	6.02	7.60	7.29	9.55	7.57	5.76	11.79	44.25	1.45	1.59	1.47	1.29	1.26	7.05
SD		5.71	3.10	2.98	4.01	2.96	2.07	3.18	3.25	4.77	3.02	5.03	8.70	1.02	1.03	0.99	0.98	1.00	3.60
Reliability (α)		.883	.909	.766	.877	.851	.851	.720	.724	.831	.930	.946	.911	–	–	–	–	–	.767

Note. Raven = Nonverbal Intelligence; OnsDel = Onset Deletion; TonDis = Tone Discrimination; RadDis = Radical Discrimination; RadIde = Radical Identification; RadMea = Radical Meaning; MorDis = Morpheme Discrimination; ComStr = Compound Structure; MeaSel = Meaning Selection; ChaRea = Character Reading; WorRea = Multi-Character Word Reading; Vocab = Vocabulary Knowledge; WorSel = Word Selection; SenSel = Sentence Selection; CoRef = Co-Reference; TexInf = Textual Inference; Gist = Gist; Total = Total Score of Text Comprehension.
* $p < .05$ ** $p < .01$ *** $p < .001$

Table 2.

Structural Parameter Estimates of the SEM Model Testing the Contributions of Different Dimensions of Morphological Awareness to Text Comprehension

Dependent Variables	Predictors	β	p	R^2	p
Word Reading	<-- Phonological Awareness	.014	.778	.773	< .001
	<--Graphomorphological Awareness	.496	< .001		
	<--Morphemic Awareness	.463	< .001		
	<--Nonverbal Intelligence	-.041	.289		
Vocabulary Knowledge	<--Phonological Awareness	-.030	.579	.692	< .001
	<--Graphomorphological Awareness	.370	< .001		
	<--Morphemic Awareness	.235	.003		
	<--Word Reading	.322	< .001		
	<--Nonverbal Intelligence	-.048	.224		
Text Comprehension	<--Phonological Awareness	.015	.794	.869	< .001
	<--Graphomorphological Awareness	.172	.107		
	<--Morphemic Awareness	.485	< .001		
	<--Word Reading	.167	.129		
	<--Vocabulary Knowledge	.200	.013		
	<--Nonverbal Intelligence	-.034	.465		
Phonological Awareness	<-->Graphomorphological Awareness	.375	< .001		
Phonological Awareness	<-->Morphemic Awareness	.329	< .001		
Morphemic Awareness	<-->Graphomorphological Awareness	.676	< .001		

Table 3.

Estimates of the Indirect Effects of Two Dimensions of Morphological Awareness on Text Comprehension

Indirect Effect Estimates	*β*	*p*
Graphomorphological Awareness → Text Comprehension	.046	.008
→ Word Reading	.020	.142
→ Vocabulary Knowledge	.018	.030
→ Word Reading → Vocabulary Knowledge	.008	.067
Morphemic Awareness → Text Comprehension	.043	.010
→ Word Reading	.022	.130
→ Vocabulary Knowledge	.013	.040
→ Word Reading → Vocabulary Knowledge	.008	.072

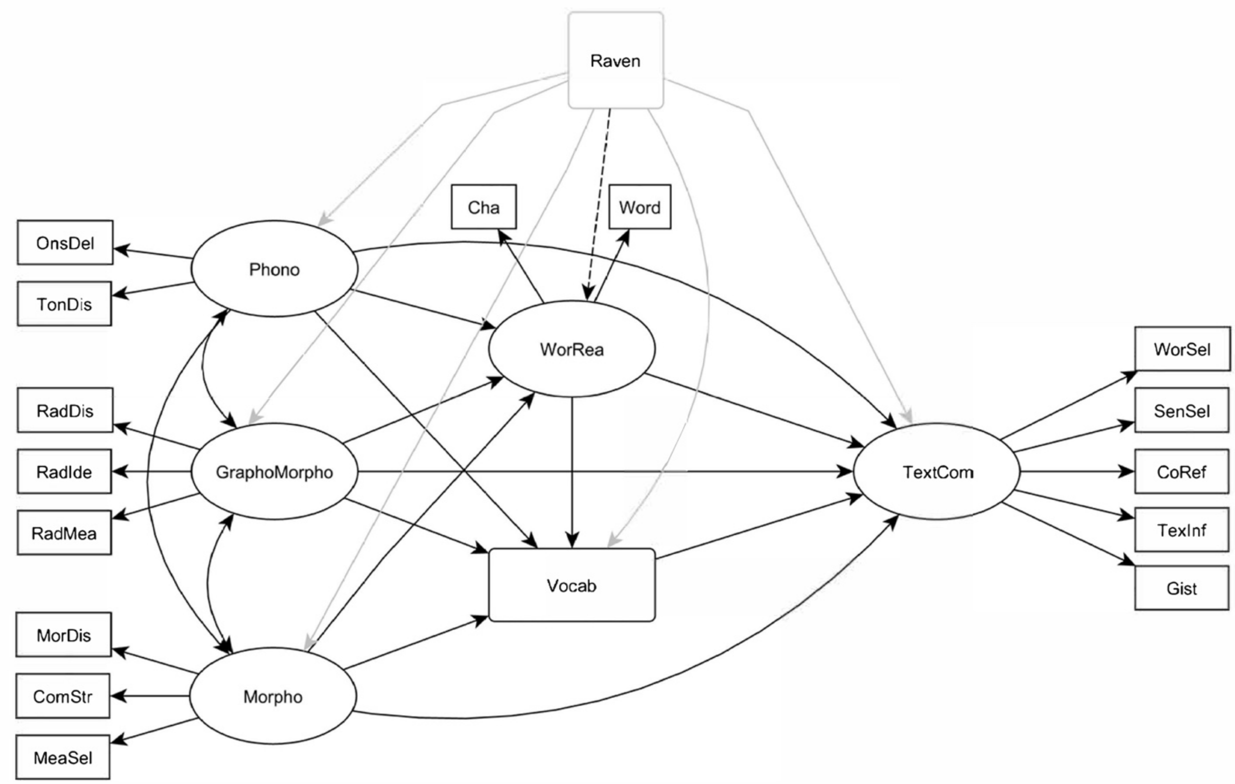

Figure 1. Conceptual Structural Equation Model testing the contributions of different dimensions of morphological awareness to text comprehension.

Note. Raven = Nonverbal Intelligence; OnsDel = Onset Deletion; TonDis = Tone Discrimination; Phono = Factor of Phonological Awareness; RadDis = Radical Discrimination; RadIde = Radical Identification; RadMea = Radical Meaning; GraphoMorpho = Graphomorphological Awareness; MorDis = Morpheme Discrimination; ComStr = Compound Structure; MeaSel = Meaning Selection; Morpho = Morphemic Awareness; Cha = Character Reading; Word = Multi-Character Word Reading; WorRea = Factor of Word Reading; Vocab = Vocabulary Knowledge; WorSel = Word Selection; SenSel = Sentence Selection; CoRef = Co-Reference; TexInf = Textual Inference; Gist = Gist; TextCom = Factor of Text Comprehension.

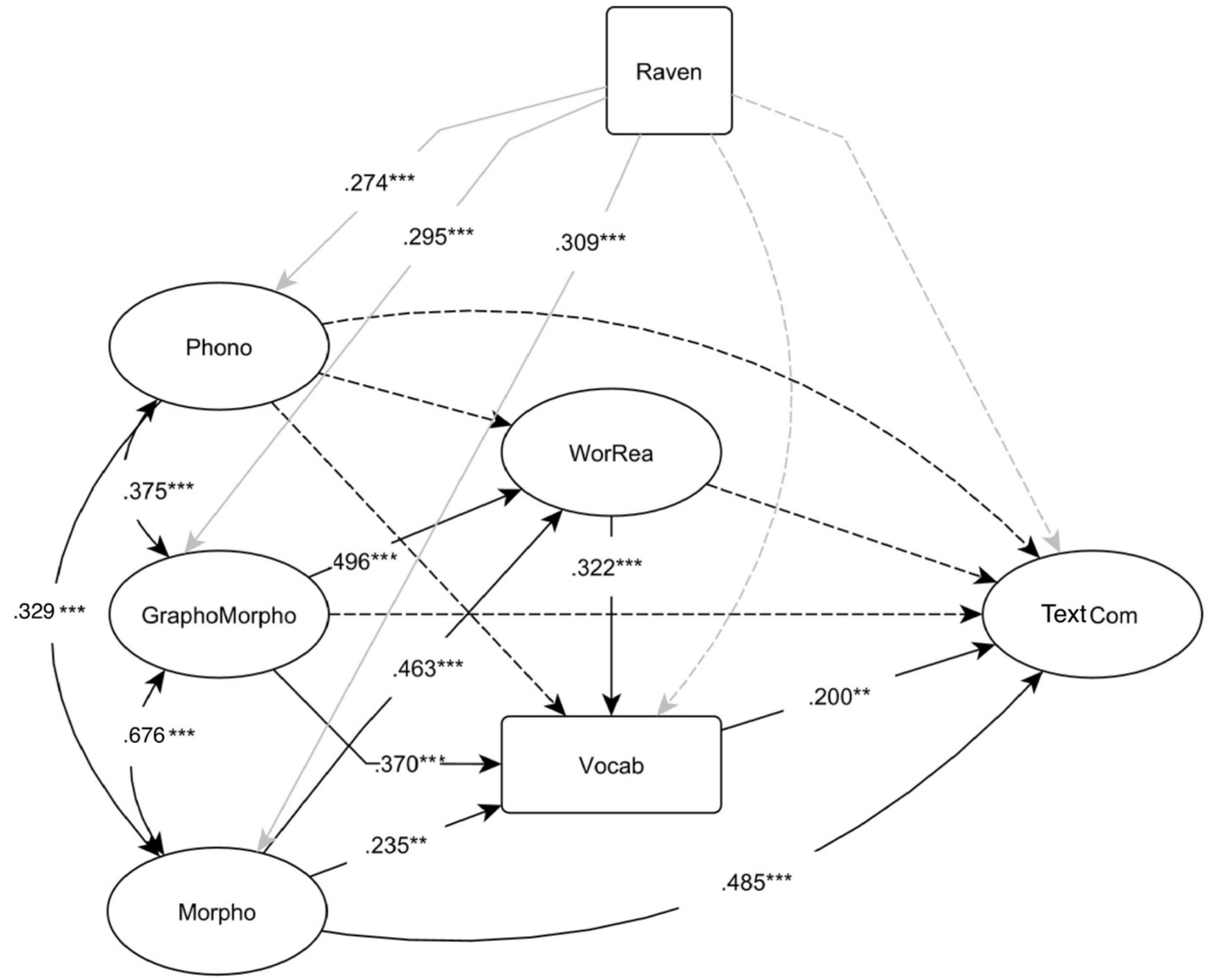

Figure 2. Structural Equation Model showing the contributions of different dimensions of morphological awareness to text comprehension with significant structural parameters.

Note. For simplicity of presentation, only structural parameters are shown with significant ones represented in solid lines and non-significant ones in dash lines.

Raven = Nonverbal Intelligence; Phono = Factor of Phonological Awareness; GraphoMorpho = Graphomorphological Awareness; Morpho = Morphemic Awareness; WorRea = Factor of Word Reading; Vocab = Vocabulary Knowledge; TextCom = Factor of Text Comprehension.

** $p < .01$ *** $p < .001$