Within- and Cross-Language Contributions of Morphological Awareness to Word Reading Development in Chinese-English Bilingual Children

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Abstract

A growing body of cross-linguistic research has suggested that morphological awareness plays a key role in both L1 and L2 word reading among bilingual readers. However, little is known about the interaction and development of L1 and L2 morphological awareness in relation to word reading. We addressed this issue by evaluating the unique contributions of L1 Chinese and L2 English morphological awareness to word reading in both Chinese and English across Grades 2 (N=150), 5 (N=158), and 8 (N=159) Hong Kong Chinese-English bilingual children. Children completed five tasks of Chinese morphological awareness which tapped for compounding awareness, homophone awareness, homographic awareness, semantic radical awareness, and affix awareness, and six English morphological judgment and analogy tasks that assessed morphological awareness at three levels: inflection, derivation, and compounding. English phonological awareness, Chinese and English vocabulary, and nonverbal ability were measured as controls. Word reading was assessed in both languages. Within-language analyses revealed that Chinese morphological awareness accounted for 27%, 22%, and 12% of unique variances in

Chinese word reading above the control measures in Grades 2, 5, and 8 respectively. In contrast, English morphological awareness explained small but significant unique variances in English word reading, i.e., 4%, 8%, and 2%, across Grades 2, 5, and 8 respectively. Critically, there were cross-language influences: Chinese morphological awareness explained 4% of unique variance in English word reading in Grade 2 after controlling for IQ, English vocabulary, English phonological awareness, and English morphological awareness; English morphological awareness explained significant variances in Chinese word reading, i.e., 4%, 3%, and 4% in Grades 2, 5, and 8 respectively, after the relevant controls. These findings suggest a bi-directional cross-language transfer of morphological awareness to word reading in L1 Chinese and L2 English. However, the direction of its transfer may be constrained by some language-specific morphological features.

Keywords: Morphological awareness, cross-language transfer, word reading, biliteracy acquisition

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Morphological awareness is children's awareness of the morphemic structure of words and ability to manipulate that structure (Carlisle, 1995). Despite differences in morphological structure across languages, morphological awareness has been proposed to be a universal part of reading (Verhoeven & Perfetti, 2011). While a majority of early studies only focused on English (e.g., Fowler, Napps, & Feldman, 1985; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Taft & Forster, 1975), Frost and Grainger (2000) emphasized the importance of cross-linguistic morphological research as it would contribute to a more complete understanding of the general principles guiding lexical organization. Chinese and English present as a potent language pairing for cross-linguistic comparisons given their striking differences in orthography and morphology (Ke & Xiao, 2015). Interestingly, there is evidence showing the transfer of Chinese morphological awareness to English morphological awareness (Zhang et al., 2010), as well as the contribution of English morphological awareness to Chinese word reading among Chinese-English bilingual readers in the

US (Wang, Cheng, & Chen, 2006). However, these studies have either focused on a single developmental stage of reading, i.e., either beginning or intermediate readers, or a restricted set of morphological awareness tasks such as only lexical compounding awareness task. Critically, the importance of morphological awareness in word reading varies across age (Nagy, Berninger, & Abbott, 2006). In addition, morphological awareness is a multifaceted construct comprised not only of compounding awareness, but also awareness of other morphological structures such as inflection and derivation (e.g., Nunes, Bryant, & Bindman, 1997; Tong & McBride-Chang, 2010). Thus, it is important to examine the roles of different aspects of morphological awareness in word reading across different developmental stages of reading. In addressing these issues, the present study tested three grades of Chinese-English bilinguals, i.e., Grades 2, 5, and 8, which represented beginning readers, intermediate readers, and advanced readers respectively. Specifically, we examined (a) the relative contributions of different types of L1 Chinese morphological awareness in L1 Chinese word reading across different stages of reading; (b) the relative contributions of different types of L2 English morphological awareness in English L2 word reading; and (c) whether there is any bi-directional transfer of morphological awareness to word reading among Chinese-English bilinguals.

Morphological Awareness as A Universal Component of Reading

Morphology has been conceptualized as a "universally part of reading" despite the constrains imposed by language and writing systems (p.465, Verhoeven & Perfetti, 2001). A considerable body of empirical research suggests that morphological awareness plays a role in reading development across different languages (see Frost & Grainger, 2000; Verhoeven & Perfetti, 2011). For example, Verhoeven, Schreuder and Haarman (2006) reported that in a lexical decision task, Dutch children and adults demonstrated higher accuracy and shorter reaction time in words with a phonological prefix than in words with a pseudoprefix, which suggest that Dutch children and adults attended to morphological information for word identification. Deacon, Wade-Woolley, and Kirby, (2007) reported that French first graders' morphological awareness uniquely contributed to French word reading above the relevant controls such as phonological awareness. Similarly, morphological awareness uniquely contributed to irregular word reading among 4- and 5- year old Korean children (Cho, McBride-Chang, & Park, 2008). The role of morphological awareness has also been identified among Finnish (e.g., Bertram, Hyönä, & Laine, 2000; Pollatsek, Hyönä, & Bertram, 2000), Hebrew (e.g., Bar-On & Ravid, 2011) and Italian readers (e.g., Marcolini, Traficante, Zoccolotti, & Burani, 2011). Together, these studies support that despite the morphological differences in terms of typology and transparency across these languages (Frost & Grainger, 2000), morphological awareness is universally important to reading development.

Morphological Awareness as Language-Specific Construct: Chinese versus English

Despite the universal role of morphological awareness in word reading, there are specific structure differences in morphological awareness across languages, such as Chinese and English. Chinese has a unique morphology which is highly contrastive to English (see Perfetti, Liu, & Tan, 2005). While a majority of English words is formed by derivation and inflection, in Chinese, compounding is the main morphological structure governing 75% of word formations (Kuo & Anderson, 2006; Sun, Sun, Huang, Li, & Xing, 1996). In compounding, categorical information is carried by the right morpheme, while sub-categorical information is carried by the left morpheme (Clark, Gelman, & Lane, 1985). Thus, the meaning of a compound word is the combination of the meaning of its two constituent morphemes. An example of such is the compound word /je6 si2/夜市 (*night market*), where the right morpheme /si2/市 carries information about the category *market*, and the left morpheme /je6/夜 (*night*) refines the categorical information *market* to *night market*. Moreover, each morpheme can form a group of semantically- related compound words, such as 夜空 (*night sky*), 夜景 (*night scene*), 夜班 (*night shift*), and 夜航 (*night flight*) all containing the morpheme 夜 (*night*), a descriptive information of time which is shared by all these compound words. Similarly, the morpheme 市 (*market*) can also form new compound words by combining with other morpheme, such as 超市 (*supermarket*), 花市 (*flower market*), and 股市 (*stock market*).

Another unique feature of Chinese morphology is the abundance of homophones, which is not commonly found in English. According to the Linguistics Society of Hong Kong (1997), Cantonese has only 1,761 tonal syllables to cover the pronunciations of more than 10,000 Chinese characters. On average, there are around six characters sharing the same pronunciation in Cantonese. For example, the five single morpheme words, e.g., 甲 (*letter A*), 夾 (*to press from either side*), 鴿 (*pigeon*), 鉀 (*potassium*), and 蛤(*toad*) all carry the same phonological information /gaap3/. Additionally, homographs are more common in Chinese than in English. For example, the same character or morpheme 月 /jyut6/ can mean *moon* or *month,* e.g., 賞月(*to admire the moon*) or 十月 (*October*). In addition to homographs, Chinese morphology is clearly distinguishable from English in terms of a unique functional unit of meaning (i.e., semantic radical) which is often embedded in semantic-phonetic compound characters (Shu, Chen, Anderson, Wu, & Xuan, 2003). In a semantic-phonetic character, the semantic radical provides the clue of the meaning or semantic category of the whole character. For example, the character 楓/fuŋ1/ (*maple*) consists of a left-sided semantic radical 木/muk6/ (*wood*), indicating the *wood/tree*-related concept. Furthermore, semantic radical is productive and it can combine with other phonetic radicals or components to form a group of characters sharing certain degree of semantic relatedness, such as 松 (*pine*), 梅 (*plum*), 桃 (*peach*), 枝 (*branch*), 柵 (*bar*), 杆 (*pole*), 植 (*plant*).

Apart from its distinctive morphology, Chinese morphology also exhibits certain similarities to English morphology. Specifically, as in English, affixation is also used to form new words in Chinese. Affixation is the process of adding affixes, i.e., bound morphemes, to different types of bases to form larger units (Li & Thomson, 1981). Similar to English, affixes can be further categorized into word-forming affix, e.g., prefix 非 (*non-*) and suffix 化 (*-ise*), and grammatical affix, e.g., infix 不 (*-not-*) and suffix 們 (*-s/-es*) (Packard, 2000).

In the recent decades, the role of different types of Chinese morphological awareness in Chinese word reading has been identified among kindergarteners and school-aged children (McBride-Chang et al., 2003; 2005; Tong et al., 2009). Among third year kindergarteners in Hong Kong, morphological awareness including compounding awareness and homophone awareness longitudinally predicted Chinese character recognition after one year (Tong et al., 2009). Similarly, compounding awareness uniquely associated with Chinese character recognition among second graders in Hong Kong (McBride-Chang et al., 2005). In another study, however, homophone awareness predicted unique variances in word reading only in 5 year-old kindergarteners but not in second graders, purportedly due to ceiling effect in the homophone identification task (McBride-Chang et al., 2003). Worthy to note, the studies above only included a limited set of morphological awareness measures, i.e., either only compounding, or both compounding and homophone. To obtain a full picture of Chinese morphological awareness and its relation with word reading, we tested a whole set of morphological awareness which included not only compounding and homophone, but also homograph, affixation, and semantic radical.

Apart from some subtypes of Chinese morphological awareness, little is known about whether the role of Chinese morphological awareness changes across different developmental levels of word reading, i.e., across early elementary, senior elementary, and early secondary grades. In fact, the roles of phonological awareness, morphological awareness, and orthographic processing in word reading have been shown to change across different stages of reading development among English children (e.g., Adams, 1990; Ehri, 1995; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009). In Chinese, although phonological awareness was important to predict kindergarteners' word reading (McBride-Chang et al., 2008), it has been suggested that its role diminishes and becomes insignificant for later primary school children (Li, Shu, McBride-Chang, Liu, & Peng, 2010). In a study which tested a set of models

(Tong & McBride-Chang, 2010), the metalinguistic underpinnings underlying word recognition varied across kindergarteners, second graders, and fifth graders. Among kindergarteners, nested model comparisons favored a model which morphological awareness and phonological awareness fell under one unitary factor, suggesting that morphology and phonological were viewed as a unitary construct. However, among fifth graders, the same set of model comparisons favored a bi-factor model in which morphological awareness and phonological awareness fell under two factors, indicating that the two constructs became separate among fifth graders. These results suggested that metalinguistic strategies in Chinese word reading varied across the developmental stages of reading. Thus, the first aim of the present study is to examine whether Chinese morphological awareness, in terms of Chinese compounding awareness, homophone awareness, homograph awareness, affixation awareness, and semantic radical awareness, predicts unique variances in Chinese word reading across Grades 2, 5, and 8 among Chinese-English bilingual readers.

In contrast, there are three types of morphology in English: inflection, derivation and compounding. Inflection refers to the modification of a word to denote verb tense, case and number, such as adding an inflectional morpheme "*s*" to the base morpheme "*dog*" to denote plurality "*dogs*". It does not involve any changes in the part of speech of the base morpheme. Derivation, on the other hand, involves a change in the part of speech or the meaning, or both. For example, adding the prefix "*un*" and suffix "-*able*" to the base morpheme "*believe*" changes the meaning and part of speech "*unbelievable*". Although not as common as in Chinese, English also exhibits words derived from compounding, e.g., sunglasses.

It has been well-established that morphological awareness is an important factor determining English word reading (e.g., Carlisle, 1995; Kirby et al., 2012). Moreover, recent research has explored how morphological awareness contributed to reading. According to Nagy, Carlisle, and Goodwin (2014), morphological awareness contributed to reading acquisition through a set of reading subskills such as decoding, spelling, word identification and lexical inferencing. For example, the segmentation of morphologically complex words into fine-grained morphemic constituents could facilitate inferences of the meaning of new words encountered (e.g., reddish) based on known morphemes (e.g., red); and inferences of its part of speech by attending to the suffix (e.g., -ish corresponds to adjectives formed from nouns).

Although the role of morphological awareness in English word reading has been well established, little is known in the context of second language learners of English, in particular Chinese-English bilingual readers (e.g., Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; McCutchen et al., 2009; Siegel, 2008). Wang and colleagues (2006) partly addressed this issue by testing Grade 2 and Grade 4 Chinese-English bilingual children in the US. In their study, English derivational awareness predicted 10% of variances in English word reading after controlling for age, grade level, English vocabulary, and English phonological awareness. To note, Wang and colleagues only included one measure of English morphological awareness, i.e., English derivational awareness, and did not examine the potential contributions of the awareness of other English morphological structures such as compounding and inflection. Also, the two grades were not separated in the regression equation, making it unclear whether the role of English morphological awareness in English word reading changed along the developmental timeline of Chinese-English bilinguals. To fully evaluate the role of morphological awareness in English word reading in English-as-a-second-language (ESL) learners along the developmental timeline, a study with fine-grain analysis in English morphological structures and their relations with English word reading was needed in different developmental levels of Chinese-English bilingual readers. The second aim of this study was to examine whether English morphological awareness, in terms of English compounding awareness, inflection awareness, and derivation awareness, predicted unique variances in English word reading among Chinese-English bilinguals.

Cross-language Transfer of Morphological Awareness

One of the theoretical foundations for the cross-language transfer of morphological awareness in bilingual reading comes from the linguistic interdependence hypothesis (Cummins, 1981). This hypothesis emphasizes that certain knowledge in one language can transfer to facilitate the acquisition of another language given adequate language exposure and motivation. Also, according to Verhoeven and Perfetti's (2011) "universal view", morphological awareness is a resource sharable across languages in literacy acquisition. Indeed, their claim has been supported by cross-linguistic studies (e.g., Bindman, 2004). For example, in a study of 6- to 10-year-old English-Hebrew bilingual children, Bindman identified unique relations between L1 English and L2 Hebrew morphological awareness above age and vocabulary, suggesting that morphological awareness is transferrable across languages.

One prominent feature of cross language transfer is directionality, which has been mostly tested from L1 to L2 (e.g., Choi, Tong, & Cain, 2016; Choi, Tong, & Singh, 2017). In contrast, very few studies have tested the L2 to L1 transfer in terms of the relation between morphological awareness and word reading (e.g., Deacon, et al., 2007; Wang et al., 2006). Hernadez and colleagues (1994) pointed out that the direction of metalinguistic transfer was determined by language proficiency, which in most cases, L1 dominant bilinguals exhibit L1 to L2 transfer. However, in the context of morphological transfer, a previous study found that L2 English compounding awareness contributed to Chinese vocabulary; but L1 Chinese compounding awareness did not contribute to English vocabulary (Pasquarella, Chen, Lam, Luo, & Ramirez, 2011). Based on this, Pasquarella and colleagues proposed that the direction of transfer was influenced by the language and writing systems, in which the transfer of compounding awareness occurred from L2 English to L1 Chinese, as Chinese has a larger amount of compound words than English.

In the context of word reading, the plausibility of L2 English to L1 Chinese morphological transfer arises from previous studies of Chinese-English bilingual children in the US (Wang et al., 2006; Wang, Yang, & Cheng, 2009). In the earlier study, Wang and colleagues examined a set of morphological skills and word reading in both Chinese and English among Chinese-English bilingual children. In the combined sample of 2nd second and 4th graders, English compound awareness accounted for 3% of unique variances in Chinese word reading after controlling for age, grade level, Chinese vocabulary, Chinese phonological awareness, and English phonological awareness. In their later study, the unique contribution of English compounding awareness to Chinese word reading sustained, even after controlling for Chinese compounding awareness. On top of these, Chinese compounding awareness did not contribute to English word reading in the two studies. In parallel with Pasquarella and colleagues (2011), the pattern of L2 to L1 morphological transfer appeared to suggest that the direction of transfer was dependent on the language and writing systems, but not relative language proficiencies (high proficiency language to low proficiency language). However, the above notion remains inconclusive due to the language background of the children tested. In their study, the children were immigrants in the US immersed in a dominant English environment with large daily exposure to English. In the two studies, the children only learnt Chinese in a Chinese class once every weekend. In the earlier study, as few as 47% of the bilingual children reported that their first language was Chinese. In the later study, parent reports indicated that only 60% of the children learnt Chinese as their first language, and 35% of them learnt English as their first language. Putting aside that a significant proportion of their samples learnt English as a first language, the demographic data and language environment were somewhat indicative that the bilingual children were in fact much more proficient in English than in Chinese. Thus, it was impossible to tease apart the possible factors governing the direction of morphological transfer. On one hand, the morphological transfer from English to Chinese might be due to higher English proficiency relative to Chinese in their sample of bilingual children. On the other hand, the direction of English to Chinese morphological transfer might be due to other factors such as the differences across English and Chinese language and writing systems as described above. Thus, we tested unbalanced Chinese-English bilingual children who were dominant in L1 Chinese, and examined whether Chinese/English morphological awareness predicted unique variance in English/Chinese word reading. On the one hand, if the direction of transfer is only determined by language proficiency, then the morphological transfer should occur from L1 Chinese to L2 English, but not from L2 English to L1 Chinese. On the other hand, if the direction of transfer was influenced by the language and writing systems in Chinese and English, L2 to L1 morphological transfer would be expected, as in Wang and colleagues' studies. Thus, the third aim of this study was to test these two plausible hypotheses.

The Present Study

The current study set out to explore the roles of L1 Chinese and L2 English morphological awareness in relation to word reading within and across Chinese and English. Three questions were addressed in this study. First, we examined the relative contributions of different types of Chinese morphological awareness in Chinese word reading across different stages of reading. Second, we examined the relative contributions of different types of English morphological awareness in English word reading across different stages of reading. Third, we examined whether morphological awareness predicted unique variance in word reading across languages. These three questions were addressed by testing three different developmental levels of children including second grade, fifth grade and eighth grade L1 dominant Chinese-English bilingual children which represented beginning, intermediate and advanced readers respectively. They were tested for word reading and vocabulary, both in Chinese and English, non-verbal intelligence, phonological awareness, and multiple measures of Chinese and English morphological awareness.

Method

Participants

Participants were 467 Hong Kong Cantonese children learning to read English as a second language. Of these, there were 150 Grade 2 students (74 boys, 76 girls; mean age = 8.10 years, *SD* = 7.28 months), 158 Grade 5 students (75 boys, 83 girls; mean age = 11.19 years, *SD* = 7.95 months), and 159 Grade 8 students (80 boys, 79 girls; mean age = 13.79 years, *SD* = 5.14 months). They were recruited from four primary schools and five secondary schools located across Kowloon, Hong Kong Island, and the New Territories, the three main regions of Hong Kong.

As reported by the participants' parents in the Language and Social Background Questionnaires adopted from Tong, Lee, Lee, & Burnham (2015), our participants were primarily from medium- to high-income families (The Hong Kong Census and Statistics Department, 2015). All were typically developing children without cognitive, language, and learning difficulties. According to parental reports, all were native Cantonese speakers. Our analyses showed that 46.6% of our participants started learning English between 4-6 year-old, and 48.0% started learning English before 3 years old. According to parent-rated proficiencies, the Chinese-English bilingual children were more proficient in Chinese than English, in both spoken and written domains (see Table 1).

Measures

Chinese compounding awareness. Children's Chinese compounding awareness was assessed with a revised version of Chinese morphological construction task (McBride-Chang et al., 2003). There were two practice trials and 24 test items ranked in ascending order of difficulty. For each item, a two-sentence scenario was first introduced orally to children, and children were asked to produce a newly formed word based on the new scenario. For example, *a gun operated by hand is called hand-gun, what is the name for a gun operated by foot?* 用手開嘅槍叫手槍。咁用腳開嘅槍叫乜野？Given our participant ranged from Grade 2 to Grade 8, we included nine four-character idioms such as 上行下效 (*Where the dam leaps over, the kid follows; Those in subordinate positions will follow the example set by their superiors*) and 扶老攜幼 (*support one's aged folk and lead one's little one by the hand*) in addition to the original test items. These items were carefully selected from local secondary school Chinese textbooks (Yu, 2012). The Cronbach's alpha reliabilities of this task were .73, .69 and .43 for second, fifth and eighth graders respectively.

Chinese homophone awareness. This 24-item Chinese homophone awareness task was developed and modified on the basis a homophone identification task (e.g., Tong, McBride-Chang, Shu, Reitsma, & Rispens, 2011). In this task, participants were told that they will hear three different two-character Chinese compound words containing a homophone morpheme. First, they were asked to determine whether the three characters are completely different. If yes, e.g., 1. 太陽 (*sun*), 2. 山羊 (*goat*), 3. 海洋 (*ocean*), they need to choose “X”. If only one of the homophone morpheme differed in writing than the other two, e.g., 1. 藍天 (*blue sky*), 2. 藍圖 (*blueprint*), and 3. 籃球 (*basketball*), children were expected to circle the number corresponding to 籃球 (*basketball*) on their answer sheets. The order of the presentation was randomized. The Cronbach’s alpha reliabilities of this task were .60, .72 and .66 for second, fifth and eighth graders respectively.

Chinese homograph awareness. We assessed children’s homograph awareness using a 30-item Chinese homographic discrimination task adopted from Tong and McBride-Chang (2010). In each trial, four two-morpheme compounds with a common written form were orally presented to children, e.g., 月光/jyt6 kwɔŋ1/ (*moonlight*), 月球/jyt6 k^{h}ɐu4/ (*the planet moon*), 月亮/jyt6 lœŋ6/ (*the moon in the sky*), and 月刊/jyt6 hɔn2/ (*monthly magazine*) all consisting of a same written form 月/jyt6/ (*moon/ month*). Children then identified the homograph which had a different meaning from the other three, which is 月刊/jyt6 hɔn2/ (*monthly magazine*) for this case. The Cronbach's alpha reliabilities of this task were .79, .72 and .62 for second, fifth and eighth graders respectively.

Chinese affix awareness. We assessed Chinese affix awareness using a 24-item Chinese affixed word formation task. In each trial, children were first orally presented with the definition of a two- or three-character compound word including the target affix. They then created a novel affixed word according to a novel expression. For example, *people who are old are called old people; what is the name for people who are strange?* 年長既人叫長者。奇怪既人叫乜野？In this task, we included prefixes such as 反 (*anti*-), 非 (*non*-), 可 (-*able*), and 再 (*re*-); and suffixes such as 家 (-*ist*), 度 (-*ness*), 學 (-*ology)*, 性 (-*ability*), and 化 (-*ise*). These affixes changed the form class of words when attached (Packard, 2000), and thus were considered as more challenging. The Cronbach's alpha reliabilities of this task were .77, .63 and .29 for second, fifth and eighth graders respectively.

Chinese semantic radical awareness. We assessed Chinese semantic radical awareness using a 36-item task adopted from Tong and McBride-Chang (2010). Each item consisted of a picture, two pseudo-characters and two non-characters. The pictures were line drawings of a simple object or concrete concept. The pseudo-characters were not real Chinese characters, but were pseudo-characters with their

Chinese semantic and phonetic radicals following the legality of radical positions. In contrast, non-characters violated the rules by reversing the positions of their semantic and phonetic radicals. For example, one of the test items had a picture of a bowl of rice, which represented the concept "飯/fan6/ (*rice*)". Since the character "飯/fan6/ (*rice*)" could be separated into the semantic radical 食/sik6/ and phonetic radical 反 /fan2/, the four stimuli were ⿰飠支 (correct semantic radical correct position), ⿰言反 (correct phonetic radical correct position), ⿰支飠 (correct semantic radical incorrect position), and ⿰反言 (correct phonetic radical incorrect position). Children were asked to select the novel symbol that best represented the meaning of the picture (i.e. ⿰飠支, the one with the correct semantic radical at the correct position). The Cronbach's alpha reliabilities of this task were .84, .86 and .87 for second, fifth and eighth graders respectively.

Chinese vocabulary. We adopted the vocabulary definition task (Tong et al., 2011) to assess children's knowledge of two-character Chinese words and four-character idioms. We chose two-character Chinese words as disyllabic words make up as much as 69.8% of modern Chinese high frequent words, relative to the 27% of monosyllabic words (He & Li, 1987). We included the four-character idioms to avoid ceiling effect among eighth graders, as four-character idioms have a higher level of ambiguity than two-character Chinese words (Hodge & Louie, 1998). In each trial, children were audibly presented with either a two-character word or a four-character idiom. They then provided an oral definition of the words. The task consisted of 30 items designed for children aged 7 to 11 (Tong et al., 2011). We added 10 new items for children aged 12 or above, and these items were chosen from local Chinese textbooks for Secondary students (Chen, Ng, & Lo, 2011; Yu, 2012). These 10 words were selected according to the rating of two experienced local Chinese language teachers in a secondary school. The selected words were rated with a difficulty level of 3 on a 5-point scale (1 = least difficult, 5 = most difficult), indicating that their difficulty level was appropriate in avoiding basal and ceiling effect. To avoid discouragement associated with early failed items, especially the more difficult four-character idioms, all 40 items were arranged in ascending order of difficulty. This task used a 0-1 point scoring system. Answers with a correct definition or a specific example were given one point while incorrect answers scored zero. For example, a 1-point response for the item 討厭 (*dislike*) would be 不喜歡 (*synonym of dislike*) whereas a 0-point response would be 唔聽話 /冇人同佢玩 (*disobedient/ no one plays with him*). Children were prompted to further explain their answers if they gave partially correct responses. Testing was stopped when the children gave five consecutive zero responses. The Cronbach's alpha reliabilities of this task were .81, .91 and .87 for second, fifth and eighth graders respectively.

Chinese word reading. A 150-item Chinese character recognition task was administered to assess children's word reading skills. Among the 150 stimuli, 70 two-character words were adopted from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (Ho, Chan, Tsang, & Lee, 2000), and the other 80 stimuli were carefully selected from a series of local Chinese textbooks for Secondary students in Hong Kong (Chen, 2011). In this task, children were asked to read aloud those words as accurately as possible. The Cronbach's alpha reliabilities of this task were .96, .95 and .90 for second, fifth and eighth graders respectively.

English inflection awareness. We assessed English inflection awareness using the English inflection analogy task and the English inflection judgment task. These two tasks assessed children's English inflection awareness on plural nouns, singular present tense, and singular past tense. In the English inflection analogy task, children were presented with a pair of real words in each trial. They then decomposed the morphological relationship between them to complete the pattern, e.g., *Lake, Lakes:: Lemon,* ____ (Nunes et al., 1997). There were three example items and 24 test items, of which half of the test items were irregular inflected forms. All real word stems used in this task have an age of acquisition less than 6 years and 6 months (Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012). For Grades 2 and 5 children, the examples were presented in both oral and written form and the children were asked to give oral responses. Grade 8 children were provided with a testing booklet to give written responses at their own pace. The Cronbach's alpha reliabilities of this task were .71, .77 and .70 for second, fifth and eighth graders respectively.

The English inflection judgment task, included three example items and 24 test items. In each item, children were given a stem together with an indicator of its word class (*to*, *the*, or *it is*) and were asked to decide which variation from the three choices best completed the sentence (e.g. To walk. Sophie is walking/ walks/ walked to school). The three choices had the same root as the target word, but only one was correctly inflected. All children completed the task by circling the answers in testing booklets. Each item was read aloud to Grades 2 and 5 children by the experimenters, while Grade 8 children worked on their own. The Cronbach's alpha reliabilities of this task were .63, .82 and .85 for second, fifth and eighth graders respectively.

English derivation awareness. We assessed English derivation awareness using the English derivation analogy task (Nunes et al., 1997) and the English derivation judgment task (Carlisle, 2000). These two tasks assessed children's English derivation awareness on verb-, adjective-, and noun-forming suffixes. The English derivation analogy task was similar to the English inflection analogy task. Children were presented with a pair of real words and needed to decompose the morphological relationship between them in order to complete the pattern, for example, *drive*, *driver*:

run, ____ . There were three example items and 20 test items. Half of the test items had the same suffixes as the pairs while half required the children to produce a different suffix. All real word stems used in this task have an age of acquisition less than 6 years and 6 months (Kuperman et al., 2012), and a broad range of suffixes were chosen from the Children's Printer Word Database (Masterson, Stuart, Dixon, & Lovejoy, 2003). For Grades 2 and 5 children, the examples were presented in both oral and written form and the children were asked to give oral responses to the experimenters. Grade 8 children were provided with a testing booklet to give written responses at their own pace. The Cronbach's alpha reliabilities of this task were .71, .67 and .68 for second, fifth and eighth graders respectively.

The English derivation judgment task was based on the Derivation task of Test of Morphological Structure (Carlisle, 2000). There were three sample items and 20 test items. Similar to the English inflection judgement task, children were given a stem together with an indicator of its word class. They then completed a sentence by choosing one of the three choices provided (e.g. *To farm. I want to be a farmist/ farmer/ farming*). The three choices provided were three variations of the stem, which included an incorrect derived form with a suffix inappropriate for its word class, the correct derived form, and an inflected form. All children completed the task by circling the answers in testing booklets. Each item was read aloud to Grades 2 and 5 children by the experimenters, while Grade 8 children worked on their own. The Cronbach's alpha reliabilities of this task were .36, .59 and .72 for second, fifth and eighth graders respectively.

English compounding awareness. We assessed English compounding awareness with the English compounding analogy task (Hamawand, 2011) and the English compounding judgment task (Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003). The English compounding analogy task consisted of 24 test items, all were novel compounds created by changing the modifier or head of existing transparent compounds, e.g., *bluebug* and *bear-wave.* Children were first presented with the definition of a real compound word. They then created a novel compound word of the same pattern, e.g., *an oil made from peanuts is called peanut oil; what is the name for oil made from mushrooms? (mushroom oil)*. Grades 2 and 5 children were tested individually and were required to give oral responses to the experimenters. Key words in written format were also presented to reduce demands on memory. On the other hand, testing booklets with full questions were provided to Grade 8 children and they worked on the questions at their own pace. The Cronbach's alpha reliabilities of this task were .75, .65 and .92 for second, fifth and eighth graders respectively.

The English compounding judgment task was based on Nagy and colleagues

(2003). The test items were created in the same way as those in the English compounding analogy task and none of them represented real concepts. In this task, children decided which novel compound from the two choices best described the description (e.g. *A bee that lives in the grass: grass bee/ bee grass*). The two compounds consisted of the same words and were varied in order only. All children completed the task by circling the answers in testing booklets. Each item was read aloud to Grades 2 and 5 children by the experimenters, while Grade 8 children worked on their own. The Cronbach's alpha reliabilities of this task were .70, .72 and .80 for second, fifth and eighth graders respectively.

Phonological awareness. We assessed phonological awareness using the elision subtest from the Comprehensive Test of Phonological Processing Second Edition (CTOPP-2; Wagner, Torgesen, & Rashotte, 1999). There were 34 test items, of which the first nine items involved deletion of a syllable from compound words and the remaining items involved the deletion of a phoneme. In each item, children were asked to repeat a word first, and say the remaining part of the word if a certain sound was deleted (e.g. Say "toothbrush". Now say "toothbrush" without saying "tooth"; or "driver" without saying "v"). Testing was discontinued if the children missed three items in a row. The Cronbach's alpha reliabilities of this task were .93, .92 and .95 for second, fifth and eighth graders respectively.

English vocabulary. A shortened version of the British Picture Vocabulary Scale Third Edition (BPVS-3; Dunn, Dunn, Styles, & Sewell, 2009) was used to measure children's receptive vocabulary. Similar modification has been used by Stanovich and Cunningham (1992). In this task, 36 age-appropriate items were selected for each group, and were presented to children through a projector. Children were asked to circle the number (1-4) corresponding to the picture that best showed the meaning of each word read aloud by the experimenters. The Cronbach's alpha reliabilities of this task were .74, .78 and .87 for second, fifth and eighth graders respectively.

English word reading. The Test of Word Reading Efficiency Second Edition (TOWRE-2; Torgesen, Wagner, & Rashotte, 2011) was used to test children's ability to pronounce printed word accurately and fluently. Both Sight Word Efficiency and Phonemic Decoding Efficiency subtests were administered. Children were first presented with a list of 108 real words with increasing difficulty and were asked to read as many words as quickly and accurately as possible within 45 seconds. The same procedures were then repeated for reading a list of 66 pronounceable non-words. The Cronbach's alpha reliabilities of this task were .98 across second, fifth and eighth graders.

Non-verbal intelligence. Matrix Reasoning, a subtest of the Wechsler

Intelligence Scale for Children Fourth Edition (WISC-IV UK; Wechsler, 2004) was used to measure children's non-verbal intelligence. There were three example items and 22, 23, and 21 test items for Grades 2, 5, and 8 children respectively. In each item, children were presented with an incomplete matrix and were asked to identify the picture that could properly complete the matrix from five options. All children individually completed the task on color-printed booklets at their own pace. The Cronbach's alpha reliabilities of this task were .60, .55 and .69 for second, fifth and eighth graders respectively.

Procedures

Informed consent was obtained from the participating schools and participants' parents before testing. Parents were also required to fill out a Language and Social Background Questionnaire (Tong et al., 2015). All testing sessions took place in quiet classrooms at the participants' schools during school hours, and were conducted by well-trained undergraduate and graduate research assistants. Chinese compound awareness, Chinese affix awareness, Chinese vocabulary definition, Chinese word reading, English phonological awareness, and English word reading were administered individually for all participants. In addition, English inflection analogy, English derivation analogy, and English compounding analogy were administered individually for Grades 2 and 5 students. The remaining measures were administered in small groups.

Results

Before addressing the three research questions, we first conducted preliminary analysis to evaluate whether all variables were normally distributed, and whether there were overall grade differences on the performance on all word reading, morphological awareness and control measures. We then addressed the first research question, i.e., the relative contributions of different types of Chinese morphological awareness in Chinese word reading across different stages of reading, by conducting three identical sets of hierarchical regressions across grade 2, 5 and 8 (see Table 5). Similarly, in addressing the second research question, i.e., the relative contributions of different types of English morphological awareness in English word reading across different stages of reading, we also conducted three identical sets of hierarchical regressions across grade 2, 5 and 8 (see Table 6). In addressing the third research question, i.e., whether morphological awareness predicted unique variance in word reading across languages, we conducted two series of hierarchical regressions across grade 2, 5 and 8 (see Table 7 and 8).

Preliminary Analysis

Distribution of the variables. Based on the skewness and kurtosis, all variables except English compounding analogy had a normal univariate distribution (Kline, 2005). According to Tabachnick and Fidell (2001), with a sample size larger than 100 cases, the effects of skewness would become less robust. With our large sample size (N = 467) and our later use of composite measure for English compounding analogy and judgement which was normally distributed, we conducted all data analyses based on the raw scores of all variables. The means and standard deviations of Chinese word reading, English word reading, Chinese vocabulary, English vocabulary, non-verbal intelligence, and phonological awareness are summarized in Table 2. Those of the English and Chinese morphological measures are summarized in Table 3.

Overall grade differences in Chinese, English and non-verbal tasks. To examine whether there were significant differences in all measures across three grades, we conducted two separate sets of multivariate analysis of variance (MANOVA), one for word reading and control measures, and one for morphological awareness measures, in both Chinese and English. The first set of MANOVA analysis was done with Chinese word reading, English word reading, Chinese vocabulary, English vocabulary, non-verbal intelligence, and phonological awareness being the dependent variables, and grade being the independent variable. There was a significant overall group effect, $\Lambda_{wilks'} = .19$, F (12, 900) = 96.89, $p < .001$. Univariate F tests revealed significant group differences in Chinese word reading, F (2, 455) = 432.99, $p < .001$, $\eta^2 = .66$, English word reading, F (2, 464) = 156.99, $p < .001$, η^2

= .40, Chinese vocabulary, F (2, 455) = 300.62, $p < .001$, $\eta^2 = .57$, English vocabulary, F (2, 464) = 24.54, $p < .001$, $\eta^2 = .10$, non-verbal intelligence, F (2, 464) = 231.40, $p < .001$, $\eta^2 = .50$, and phonological awareness, F (2, 464) = 92.49, $p < .001$, $\eta^2 = .29$. Pairwise comparisons with Bonferroni adjustment indicated that Grade 8 outperformed the other two grades, and that Grade 5 outperformed Grade 2 in Chinese word reading, English word reading, Chinese vocabulary, non-verbal intelligence and phonological awareness measures, *ps* < .001.

We conducted the second set of MANOVA analysis with measures of Chinese and English morphological awareness. We entered Chinese compounding awareness, Chinese homophone awareness, Chinese homograph awareness, Chinese affixation awareness, Chinese semantic radical awareness, English compounding awareness (both analogy and judgement) English inflection awareness (both analogy and judgement), and English derivation awareness (both analogy and judgement) as the dependent variables, and grade as the independent variable. A significant overall group effect was evident, $\Lambda_{\text{wilks'}} = .23$, F (22, 878) = 43.45, $p < .001$. Univariate F tests revealed significant group differences in Chinese compounding awareness, F (2, 455) = 131.53, $p < .001$, $\eta^2 = .37$, Chinese homophone awareness, F (2, 463) = 237.54, $p < .001$, $\eta^2 = .51$, Chinese homograph awareness, F (2, 460) = 243.73, $p < .001$, $\eta^2 = .51$, Chinese affixation awareness, F (2, 455) = 125.89, $p < .001$, $\eta^2 = .36$, Chinese semantic radical awareness, $F(2, 462) = 52.12$, $p < .001$, $\eta^2 = .18$, English inflection judgement, $F(2, 463) = 230.16$, $p < .001$, $\eta^2 = .50$, English derivation judgement, $F(2, 463) = 131.20$, $p < .001$, $\eta^2 = .36$, English compounding judgement, $F(2, 463) = 62.85$, $p < .001$, $\eta^2 = .21$, English inflection analogy, $F(2, 456) = 44.33$, $p < .001$, $\eta^2 = .16$, English derivation analogy, $F(2, 456) = 51.77$, $p < .001$, $\eta^2 = .19$, and English compounding analogy, $F(2, 454) = 20.82$, $p < .001$, $\eta^2 = .08$. Pairwise comparisons with Bonferroni adjustment indicated the outperformance of Grade 8 over the two other grades, and the outperformance of Grade 5 over Grade 2 in Chinese compounding awareness, Chinese homophone awareness, Chinese homograph awareness, Chinese affixation awareness, Chinese semantic radical awareness, English inflection judgement, English derivation judgement, English compounding judgement, English derivation analogy, and English compounding analogy, *ps* < .05. For English inflection analogy, Grade 5 and Grade 8 outperformed Grade 2, *ps* < .001. For English compounding analogy, Grade 5 outperformed Grade 8 and Grade 2, *ps* < .001.

Correlational Analyses

Before examining the unique contributions of morphological awareness to word reading within and across Chinese and English, we first conducted correlational analyses among all the variables. The correlations between all variables and word reading, in both Chinese and English, are summarized in Table 4.

Within-language correlations. Related to the first research question, all Chinese morphological awareness measures, i.e., Chinese compounding awareness, Chinese homophone awareness, Chinese homographic awareness, Chinese affixation awareness, and Chinese semantic radical awareness were significantly associated with Chinese word reading in Grades 2, 5, and 8, *ps* < .05.

Similarly, in relation to the second research question, there were significant associations between four English morphological awareness measures, i.e., English inflection analogy, English derivation analogy, English inflection judgment, and English derivation judgment, and English word reading in Grades 2, 5, and 8, *ps* < .05. English compounding analogy and English compounding judgment were significantly associated with English word reading only in Grade 5 and Grade 8, *ps* < .05.

Cross-language correlations. With regard to the third research question, four Chinese morphological awareness measures, i.e., Chinese compounding awareness, Chinese homophone awareness, Chinese homograph awareness, and Chinese semantic radical awareness correlated with English word reading in Grades 2, 5 and 8, *ps* < .05. Also, Chinese affixation awareness was correlated with English word reading in Grade 2, *p* < .05. Additionally, in Grade 2, English compounding analogy and English inflection judgement correlated with Chinese word reading, *ps* < .05. In Grade 5, both analogy and judgment tasks for English inflection awareness and English derivation awareness correlated with Chinese word reading, *ps* < .01. In Grade 8, English derivation analogy correlated with Chinese word reading, *p* < .05.

The subsequent within-language and cross-language analyses were largely based on the associations between measures of morphological awareness and word reading, both in Chinese and English, as reported above.

Within-language Contribution of Morphological Awareness to Word Reading

To address the first research question, we examined the unique contribution of Chinese morphological awareness to Chinese word reading in Grades 2, 5 and 8, by conducting three identical sets of hierarchical regressions (see Table 5). In the first step, we controlled for general ability and vocabulary by entering non-verbal intelligence and Chinese vocabulary into the regression equation explaining Chinese word reading in Grade 2. Together, non-verbal intelligence and Chinese vocabulary accounted for 12% of variances in Chinese word reading. In the second step, we entered phonological awareness given its correlation with Chinese word reading in Grade 5 (see Table 4). The inclusion of phonological awareness in the model did not account for any additional variance in Chinese word reading. In the last step of the hierarchical regression, we added five measures of Chinese morphological awareness, i.e., Chinese compounding awareness, Chinese homophone awareness, Chinese homograph awareness, Chinese affixation awareness, and Chinese semantic radical awareness. Together, these five measures of Chinese morphological awareness uniquely accounted for 27% of variances in Chinese word reading. We did two identical sets of hierarchical regressions for Grade 5 and Grade 8 (see Table 5). The five measures of Chinese morphological awareness together predicted 22% and 12% of unique variances in Chinese word reading respectively in Grade 5 and Grade 8, after taking into account non-verbal intelligence, Chinese vocabulary, and phonological awareness.

The final beta weights of all the variables in their contribution to Chinese word reading across grades are listed in Table 5. Among all morphological awareness measures in Grade 2, Chinese compounding awareness and Chinese homograph awareness were the only significant predictors of Chinese word reading. Among those in Grade 5, only Chinese homophone awareness predicted unique variance in Chinese word reading. In Grade 8, only Chinese homophone awareness and Chinese homograph awareness contributed uniquely to Chinese word reading among the five Chinese morphological awareness measures.

In addressing the second research question, we examined the unique contribution of English morphological awareness to English word reading in Grades 2, 5, and 8 by conducting three identical sets of hierarchical regressions (see Table 6). In the first step, we entered non-verbal intelligence and English vocabulary to the equation, in light of the correlation between English word reading and English vocabulary. In the second step, we entered English phonological awareness given the correlation between English word reading and English phonological awareness. In the final step, we entered three composite measures of English morphological awareness, i.e., English compounding awareness, English inflection awareness and English derivation awareness. Each of the composite measure consisted of the composite score of the judgement and analogy tasks. For example, the English compounding awareness was computed with the sum of English compounding judgement, and English compounding analogy. As summarized in Table 6, the final models accounted for 59%, 70%, and 64% of variances in English word reading in Grades 2, 5 and 8. Together, the three English morphological awareness measures uniquely accounted for 4%, 8%, and 2% of variances in in English word reading taking into account non-verbal intelligence, English vocabulary, and phonological awareness in Grades 2, 5, and 8 respectively.

Table 6 summarizes the final beta weights of all variables. Among the English morphological awareness measures in Grades 2 and 5, English inflection awareness was the only significant predictor of English word reading.

Cross-language Contribution of Morphological Awareness to Word Reading

In addressing the third research question, we first examined the unique contribution of Chinese morphological awareness to English word reading. We conducted a hierarchical regression similar to the within-language regression equation of English word reading, but with the five measures of Chinese morphological awareness added in the final step (see Table 7). In this hierarchical regression, we first added non-verbal intelligence and English vocabulary. In the second step, we added phonological awareness into the equation. In the third step, we added the three measures of English morphological awareness, i.e., English compounding awareness, English inflection awareness, and English derivation awareness into the equation. In the final step, we added the five measures of Chinese morphological awareness, i.e., Chinese compounding awareness, Chinese homophone awareness, Chinese homograph awareness, Chinese affixation awareness, and Chinese semantic radical awareness. As summarized in Table 7, in the final equations, Chinese morphological awareness predicted 4% of variances in English word reading only in Grade 2, after taking into account non-verbal intelligence, English vocabulary, English phonological awareness, and English morphological awareness.

The final beta weights of all variables are summarized in Table 7. Among the Chinese morphological awareness in Grade 2, only Chinese homophone awareness contributed uniquely to English word reading. In Grades 5 and 8, Chinese morphological awareness had no statistically significant contribution to English word reading after taking into account the relevant controls, *ps* > .05.

We also addressed the third research question by examining the unique contribution of English morphological awareness to Chinese word reading. We conducted a similar set of hierarchical regression as the within-language regression equation of Chinese word reading, but with the three composite measures English morphological awareness added in the final step (see Table 8). In the first step, we added non-verbal intelligence and Chinese vocabulary to the regression equation. Next, we added phonological awareness in the second step. In the third step, we added the five measures of Chinese morphological awareness into the equation. In the final step, we added the three composite measures of English morphological awareness, i.e., English compounding awareness, English inflection awareness, and English derivation awareness. As shown in Table 8, the three composite measures of English morphological awareness together predicted 4%, 3%, and 4% of variances in Chinese word reading in Grades 2, 5, and 8, after taking into account the relevant controls.

Table 8 summarizes the final beta weights of all variables. Among the English morphological awareness measures in Grade 2, only English derivation awareness significantly predicted Chinese word reading. Among those in Grades 5 and 8, English compounding awareness was the only predictor of Chinese word reading.

Discussion

The present study aimed to address three questions, i.e., (1) whether Chinese morphological awareness contributed to Chinese word reading across different stages of reading, (2) whether English morphological awareness contributed to English word reading across different stages of reading, and (3) whether morphological awareness predicted unique variance in word reading across languages. Consistent with our predictions, it was found that morphological awareness predicted unique variances in word reading, within both Chinese and English, and the contributing roles of specific constituents varies across the developmental timeline. For example, Chinese compounding awareness contributed to Chinese word reading among second graders, but not among fifth and eighth graders. Across languages, L2-to-L1 morphological transfer was evident among the three groups, while L1-to-L2 morphological transfer was only exhibited among second graders.

Within-language Morphological Contribution to Word Reading

One of the important findings in the current study was the developmental differences in the role of Chinese morphological awareness in Chinese word reading. Among the several measures of Chinese morphological awareness, Chinese compounding awareness contributed to Chinese word reading only among Grade 2.

Given the predominance of compound words in Chinese (Liu & McBride-Chang, 2010), it was not surprising that the awareness of lexical compounding structure was important in processing Chinese among the second graders. In particular, their understanding of lexical compounding structure might enable them to make use of known morphemes to partially recognize words or infer word meanings. For example, the known morpheme 茶/ts^{h}a4/ (*tea*) in 綠茶/luːk6 ts^{h}a4/ (*green tea*) might partially activate words in the semantic category, e.g., 綠茶/luːk6 ts^{h}a4/ (*green tea*), 紅茶 /huːŋ4 ts^{h}a4/ (*red tea*), 玄米茶/jyːn4 mɐi5 ts^{h}a4/ (*roasted brown rice tea*), and 檸檬茶/liːŋ4 mɐŋ1 ts^{h}a4/ (*lemon tea*), facilitating subsequent retrieval. Compounding structure might also help infer the meaning when the word was unknown. For example in the case where the morpheme 檸檬/liːŋ4 mɐŋ1/ (*lemon*) was unknown, readers could still rely on the morpheme 茶/ts^{h}a4/ (*tea*) to acknowledge that 檸檬茶 was a kind of tea. Worthy to note, Chinese compounding awareness seemed less important in Grades 5 and 8 word reading. According to previous studies, lexical compounding was the easiest morphological structure in Chinese, and was acquired earliest among Chinese children (Chen et al., 2008; Ku & Anderson, 2003). As children became intermediate (Grade 5) and advanced (Grade 8) readers, compounding structures might become too primitive to support Chinese word reading. Consistent with Tong and McBride-Chang (2010) who showed different strategic uses of metalinguistic awareness across age, the present results suggest that the Chinese readers rely on more sophisticated morphological skills as their reading level advances, such as Chinese homophone awareness.

The role of Chinese homophone awareness in Chinese word reading was found only among more advanced readers, i.e., fifth and eighth graders. Worthy to note, among less experienced readers such as kindergarteners (Zhou, McBride-Chang, Fong, Wong, & Chong, 2012) and the second graders we examined, Chinese homophone awareness did not seem to contribute to word reading. This was surprising given the large number of homophones in Chinese (Tong et al., 2011). One possible reason was that less experienced readers, in this case the second graders, had not obtained a vocabulary size large enough to be aware that morphemes could share the same sound but differ in meaning. However, as older children had larger vocabulary size and increased experience with homophones, the role of homophone awareness became particularly important for them.

As for Chinese homograph awareness, it contributed to Chinese word reading only in Grades 2 and 8. Given the abundance of homographs, e.g., 謝/ts^{h}ɛ 4/ can mean *a surname*, *wilt* or *thank*, Chinese readers need to be sensitive to the multiple meanings of the same morpheme sharing the same print and sound (Liu et al., 2013). However, homograph awareness did not seem to contribute to word reading among fifth graders. According to the developmental model by Tong and McBride-Chang (2010), fifth graders tended to perceive character as an integration of sound and meaning, in which meaning and form were not clear cut. Thus, the connection between sound and meaning, as in the case of homophones, became more important for fifth graders. Placing this to the current context, it appeared to be the case that Chinese homophone awareness was more important than Chinese homograph in Chinese word reading for fifth graders.

Another important finding in the current study was that English morphological awareness contributed to English word reading across the three grades of Chinese-English bilingual readers. This has extended previous studies relating morphological awareness and English word reading in native English children (e.g., Carlisle & Nomanbhoy, 1993; Deacon & Kirby, 2004; Siegel, 2008). Specifically, we tested a whole set of English morphological skills, and showed that English morphological awareness was important not only for native English children, but also for English learning children in Hong Kong across elementary to early secondary grades.

Of particular interest was that English inflection awareness contributed to English word reading only in Grades 2 and 5. According to studies of word reading development, strategies underpinning word reading could be influenced by the teaching methodology applied to children (Geary, 2002; Leong, Hau, Cheng, & Tan, 2005; Yin, Anderson, & Zhu, 2007; Wang & Geva, 2003). Given that English has a relatively simpler inflectional system than derivational system (Chen et al., 2008), and that inflectional morphological structure is explicitly taught in early elementary grades, it is not surprising that English inflection awareness accounted for English word reading among second and fifth graders. This was not observed among eighth graders. One possible reason was that English vocabulary played an increasingly important role in English word reading over the developmental timeline, reflected by regressions that English vocabulary predicted 34%, 38% and 52% of variance in English vocabulary in Grades 2, 5, and 8 respectively. Thus, in Grade 8, English inflection awareness might have become less important, relative to English vocabulary, for English word reading.

English compounding awareness did not seem to contribute to English word reading across the three grades. This was not surprising as English had very few compound words relative to Chinese (Chen et al., 2008), making compounding less salient for English word reading. As for the case of English derivational awareness, derivation structure was acquired relatively late even among native English readers (Anglin, 1993; Carlisle, 2003). Given that the readers we tested were second language English learners, it was reasonable to conceive that their understanding of derivation structure was insufficient to support English word reading.

Cross-language Morphological Contribution to Word Reading

The present results indicate that Chinese morphological awareness transfers to English word reading among second graders. Previous studies demonstrated that homophone awareness associated with word reading in alphabetical languages such as English and French (McBride-Chang, Manis, Seidenbery, Custodio, & Doi, 1993; Sprenger-Charolles, Siegel, & Bechennec, 1998). Speculatively, we believe that the contribution of Chinese homophone awareness to English word reading may arise from its shared processes with English homophone awareness. Specifically, it has been suggested that homophone awareness might enhance readers' ability to link specific sounds with specific morphemes (Tong et al., 2011), an important skill in English word reading. To note, Chinese homophone awareness did not seem to play a role in fifth and eighth graders' English word reading. One possible account might be that once the English proficiency had reached a certain degree, less support was needed from the native language. This account was consistent with previous findings in which transfer from L1 to L2 occurred primarily at early stages of L2 acquisition, and decreased as L2 proficiency increased (e.g., Chan, 2004; Kellerman, 1979; Taylor, 1975).

The most striking finding in the current study was the negative transfer of English morphological awareness to Chinese word reading. Given that compounding was the main morphological structure in Chinese, we expected a positive transfer from English compounding awareness to Chinese word reading, as was found in a previous study (Wang et al., 2009). Inconsistent with our prediction, negative transfer was observed in the current study. Speculatively, the negative transfer might be explained by grain size differences between Chinese and English compounding. English compounding takes the form of word-to-word compounding (e.g., sun + glasses → sunglasses) which has a large grain size. In contrast, Chinese compounding can take the form of character compounding (e.g., 夜+市→夜市) and sub-character compounding (谷 and 卩→卻), in which the later has a smaller grain size. It might be possible that English compounding had orientated the bilingual children towards analyzing the morphological structure in a larger grain size, interfering with sub-character compounding. In particular, Chinese second and fourth graders have been shown to make use of sub-character information in pronouncing unfamiliar semantic-phonetic compound words (He, Wang, & Anderson, 2005). Thus, it is not unreasonable to speculate that the interference in sub-character processing might have affected Chinese word reading.

Although it remains unclear about why the current results of negative transfer contradict with the positive transfer found in Wang and colleagues' (2009) study, a potential explanation lies in the differences in language background between our samples. While the children we tested were native and dominant in Cantonese, the children in Wang and colleagues' study grew up in an English-dominant environment, and a considerable proportion of children even learnt Chinese as L2. A previous study on English learners of Chinese reported that they relied on root repetition, rather than using radical as a cue when learning new characters (McGinnis, 1999). Contrastively, a study on native Chinese learners demonstrated that native Chinese children attend to radicals as early as third grade (Shu & Anderson, 1997). Speculatively, given that sub-character processing might play a more important role among the native Chinese children than those in Wang and colleagues' study, the negative transfer from L2 English to L1 Chinese was observed herein but not in the previous study. However, we are aware of the speculative nature of this explanation and future research is needed to further explore the plausible reasons of such a negative transfer of L2 English morphological awareness to Chinese word reading.

Apart from English compounding awareness, we identified a negative transfer from English derivation awareness to Chinese word reading. Over-generalization might offer a possible explanation. In English derivation morphology, suffixes are used consistently to alter the root words, e.g., *-er* in *runner* and *painter*. Unlike English, Chinese has very few reliable derivation suffixes, e.g., 家/ka1/ can mean *family*, *expert* or *ideology* in 李家/lei2 ka1/ (*Lee family*), 畫家/wa2 ka1/ (*painter*) and

儒家/jy:4 ka1/ (*Confucianism*). It might be possible that the Chinese-English bilingual readers applied derivational morphological knowledge in English when reading Chinese. The incorrect understanding or use of derivational suffixes in Chinese might hinder word reading. Placing the findings of negative morphological transfer into the context of Hong Kong, it might be the case that L2 English learning experience hindered L1 Chinese learning, at least in word reading.

Theoretical Implication

While a majority of cross-language studies have focused on how second language acquisition is influenced by first language experience (e.g., Abu-Rabia, 2001; Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Yamashita, 2002), the L2-to-L1 transfer identified herein suggests that there is also a need to evaluate the possible influence of less dominant L2 to more dominant L1. Worthy to note, the linguistic interdependence hypothesis (Cummins, 1979) posited positive transfer from one language to another. However, our findings of negative transfer indicate that cross-language influence is not necessarily positive. In cross-linguistic studies, negative transfer was largely evident in phonological (e.g., Goto, 1971) and spelling (e.g., Figueredo, 2006) domains. For example, Goto found that Japanese adults learning English as L2 have difficulty perceiving /r/-/l/ phonological contrast, presumably due to the lack of /r/-/l/ contrast in Japanese. The current study provides new evidence suggesting that negative transfer is also evident in the morphological domain.

As for the direction of metalinguistic transfer, our results suggest that it is not determined only by language proficiency. Specifically, the Chinese-English bilinguals we examined were dominant in Chinese, and they exhibited transfer from less proficient L2 English to more proficient L1 Chinese. This is in contrary to the "proficiency governs direction" claim (e.g., Hernandez et al., 1994), and suggests that the direction of metalinguistic transfer is also governed by other factors. In line with previous studies (e.g., Wang et al., 2006; 2009), the current study provides new evidence that the differences in Chinese and English morphological systems may influence the direction of morphological transfer. For example, compounding word structure is more abundant in Chinese than in English (Pasquarella et al., 2011), implying that compounding awareness plays a more important role in word reading in Chinese than in English. Indeed, in the current study, the direction of transfer for compounding occurred from L2 English to L1 Chinese. It would be worthwhile for future studies to investigate possible factors which determine the direction of metalinguistic transfer.

Educational Implication

The role of morphological awareness in word reading suggests its potential use for screening and treatment for Chinese or English reading difficulties among

Chinese-English bilingual readers. In this regard, Zhou and colleagues (2012) found that lexical compounding training improved both word reading and vocabulary knowledge among Chinese kindergarteners. In addition, Tong, Tong, and McBride-Chang (2015) discovered that Chinese-English bilingual second and fifth graders exhibiting Chinese and English word reading difficulties had lower levels of morphological awareness than average readers. This suggested a linkage between morphological awareness and word reading difficulties. Future clinical studies may evaluate the efficacy for providing morphological training to Chinese-English bilingual readers who struggle in Chinese and English word reading.

Limitation and Future Studies

One of the limitations of the present study was directionality. With a cross-sectional design, the present study could not provide strong evidence differentiating whether morphological awareness influenced word reading, or vice-versa. Also, the developmental changes in morphological awareness were examined in a cross-sectional manner across Grades 2, 5, and 8. A longitudinal study is needed to track true developmental changes in morphological awareness, and examine the causal relations between morphological awareness and reading. To establish a stronger causal relation, the longitudinal study should preferably start in the preschool period before literacy acquisition. Apart from that, the current study only investigated sequential Chinese-English bilinguals in Hong Kong. It would be worthwhile to investigate a wider range of Chinese-English bilinguals, e.g., simultaneous bilinguals and bilinguals immersed in an English dominant environment, and examine whether these factors influences morphological transfer. Additionally, an inclusion of English homophone task would strengthen the proposed claim that the contribution of Chinese homophone awareness to English word reading was associated with its shared processes with English homophone awareness

Conclusion

There were within-language and cross-language contributions of morphological awareness to word reading in Chinese-English bilingual readers. Within Chinese and English, morphological awareness contributed to word reading above the relevant controls across Grades 2, 5, and 8 bilingual readers. More importantly, we identified a bi-directional transfer of morphological awareness to Chinese and English word reading. Specifically, Chinese morphological awareness contributed to English word reading among second graders; English morphological awareness accounted for unique variances in Chinese word reading across the three grades. These results not only highlight the role of morphological awareness in Chinese and English word reading, but also shed light on two important issues in bilingual research. First, the results implied a need to include elements of negative transfer in cross-linguistic morphology research. Second, future empirical studies are warranted to investigate the possible factors influencing the direction of metalinguistic transfer.

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References

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

Adams, M. (1990). *Beginning to read: Thinking and learning about print*. Cambridge, MA: MIT Press.

Anglin J. M. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society for Research in Child Development, 58*(10), 1-166.

Bar-On, A., & D. Ravid. (2011). Morphological decoding in Hebrew pseudowords: a developmental study. *Applied Psycholinguistics*, *32*, 553–581.

Bertram, R., Laine, M., Schreuder, R., Baayen, R. H., & Hyönä, J. (2000). Affixal homonymy triggers full form storage, even with inflected words, even in a morphologically rich language. *Cognition*, *74*, B13-B25.

Bindman, M. (2004). Grammatical awareness across languages and the role of social context: Evidence from English and Hebrew. In T. Nunes & P. Bryant (Eds.), *Handbook of children's literacy* (pp. 691-709). Dordrecht, the Netherlands: Kluwer.

Carlisle, J. F. (1995). Morphological awareness and early reading achievement. In L. B. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189-209). Hillsdale, NJ: Erlbaum.

Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words: Impact on reading. *Reading and Writing, 12*, 169-190.

Carlisle, J. F. (2003). Morphology matters in learning to read: A commentary. *Reading Psychology, 24(3-4),* 291-322. doi:10.1080/ 02702710390227369

Carlisle, J. F., & Nomanbhoy, D. M. (1993). Phonological and morphological awareness in first graders. *Applied psycholinguistics*, *14*(2), 177-195. doi: 10.1017/S0142716400009541

Chan, A. Y. (2004). Syntactic transfer: Evidence from the interlanguage of Hong Kong Chinese ESL learners. *Modern Language Journal, 88*(1), 56-74.

Chen, W. L., Ng, S. Y. J., Lo, O. L. (2011). *新編啟思中國語文* (New Chinese language textbook). Hong Kong, China: Oxford University Press.

Chen, X., Hao, M., Geva, E., Zhu, J., & Shu, H. (2008). The role of compound awareness in Chinese children's vocabulary acquisition and character reading. *Reading and Writing*, *22*(5), 615-631. doi: 10.1007/s11145-008-9127-9

Cho, J. R., McBride-Chang, C., & Park, S. G. (2008). Phonological awareness and morphological awareness: Differential associations to regular and irregular word recognition in early Korean Hangul readers. *Reading and Writing*, *32*, 255-274.

Choi, W., Tong, X., & Cain, K. (2016). Lexical prosody beyond first-language boundary: Chinese lexical tone sensitivity predicts English reading comprehension. *Journal of Experimental Child Psychology*, *148*, 70-86. doi:10.1016/j.jecp.2016.04.002

Choi, W., Tong, X., & Singh, L. (2017). From lexical tone to lexical stress: A cross-language mediation model for Cantonese children learning English as a second language. *Frontiers in Psychology*, *8*, 492. doi:10.3389/fpsyg.2017.00492

Clark, E. V., Gelman, S. A., & Lane, N. M. (1985). Compound nouns and category structure in young children. *Child Development*, *56*(1), 84-94. doi: 10.2307/1130176

Cummins, J. (1981). The role of primary language development in promoting educational success for language minority students. *In Schooling and Language Minority Students* (pp. 3-49). Sacramento, CA: California Department of Education.

Deacon, S. H., & Kirby, J. R. (2004). Morphological awareness: Just "more phonological"? The roles of morphological and phonological awareness in reading development. *Applied psycholinguistics*, *25*(2), 223-238. doi: 10.1017.S0124716404001117

Deacon, S. H., Wade-Woolley, L., & Kirby, J. (2007). Crossover: The role of morphological awareness in French Immersion children's reading. *Developmental Psychology*, *43*(3), 732-746.

Dunn, L. M., Dunn, D. M., Styles, B., & Sewell, J. (2009). *British Picture Vocabulary Scale: 3rd Edition.* London, United Kingdom: GL Assessment.

Durgunoğlu, A. Y., Nagy, W. E., & Hancin-Bhatt, B. J. (1993). Cross-language transfer of phonological awareness. *Journal of Educational Psychology*, *85*(3), 453-465.

Ehri, L. C. (1995). Phases of development in learning to read words by sight. *Journal of Research in Reading*, *18*(2), 116-125.

Figueredo, L. (2006). Using the known to chart the unknown: A review of first-language influence on the development of English-as-a-second-language spelling skill. *Reading and Writing*, *19*, 873-905.

Fowler, C. A., Napps, S. E., & Feldman, L. B. (1985). Relations among regular and irregular morphologically related words in the lexicon as revealed by repetition priming. *Memory and Cognition*, *13*, 241-255.

Frost, R., & Grainger, J. (2000). Cross-linguistic perspectives on morphological processing: An introduction. *Language and Cognitive Processes*, *15*(4/5), 321-328.

Geary, D. C. (2002). Principles of evolutionary educational psychology. Learning and Individual Differences, 12, 317–345.

Goto, H. (1971). Auditory perception by normal Japanese adults of the sounds "l" and "r". *Neuropsychologia*, *9*(3), 317–323,

Hamawand, Z. (2011). *Morphology in English: Word formation in cognitive grammar*. London, United Kingdom: Bloomsbury Publishing.

He, K., & Li, D. (1987). *Xiandai Hanyu Sanqian Changyongci Biao [Three thousands commonly used words in Mandarin]*. Beijing: Beijing Normal University.

He, Y.Q., Wang, Q.Y. & Anderson, R. (2005). Chinese children's use of subcharacter information about pronunciation. *Journal of Educational Psychology, 97*(4), 572–579. doi: 10.1037/0022-0663.97.4.572

Hernandez, A. E., Bates, E. A., & Avila, L. X. (1994). On-Line Sentence Interpretation in Spanish-English Bilinguals: What Does It Mean to Be "In Between"? *Applied Psycholinguistics, 15*, 417-446.

Ho, C. S. H., Chan, D. W., Tsang, S. M., & Lee, S. H. (2000). *The Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD) manual.* Hong Kong, China: Hong Kong Specific Learning Difficulties Team.

Hodge, B., & Louie, K. (1998). *The Politics of Chinese Language and Culture: The Art of Reading Dragons*. London & New York: Routledge.

Hong Kong Census and Statistics Department. (2015). *Hong Kong Annual Digest of Statistics*. Retrieved from http://www.statistics.gov.hk/pub/B10100032015AN15B0100.pdf

Ke, S., & Xiao, F. (2015). Cross-linguistic transfer of morphological awareness between Chinese and English. *Language Awareness*, *24*(4), 355-380.

Kellerman, E. (1979). Transfer and non-transfer: Where we are now. *Studies in Second Language Acquisition*, *2*(1), 37-57.

Kirby, J. R., Deacon, S. H., Bowers, P. N., Izenberg, L., Wade-Woolley, L., & Parrila, R. (2012). Children's morphological awareness and reading ability. *Reading and Writing*, *25*, 389-410.

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. New York, NY: Guilford publications.

Ku, Y. M., & Anderson, R. C. (2003). Development of morphological awareness in Chinese and English. *Reading and Writing*, *16*(5), 399-422.

Kuo, L. J., & Anderson, R. C. (2006). Morphological awareness and learning to read: A cross-language perspective. *Educational Psychologist*, *41*(3), 161-180.

Kuperman, V., Stadthagen-Gonzalez, H., & Brysbaert, M. (2012). Age-of-acquisition ratings for 30,000 English words. *Behavior Research Methods*, *44*, 978-990. doi: 10.3758/s13428-012-0210-4

Leong, C. K., Hau, K. T., Cheng, P. W., & Tan, L. H. (2005). Exploring two-wave reciprocal structural relations among orthographic knowledge, phonological sensitivity, and reading and spelling of English words by Chinese students. *Journal of Educational Psychology*, *97*(4), 591-600. doi: 10.1037/0022-0663.97.4.591

Li, C. N., & Thompson, S. A. (1981). *Mandarin Chinese: A Functional Reference Grammar.* Berkeley, CA: University of California Press.

Li, H., Shu, H., McBride-Chang, C., Liu, H., & Peng, H. (2012). Chinese children's character recognition: Visuo-orthographic, phonological processing and morphological skills. *Journal of Research in Reading*, *35*(3), 287-307. doi: 10.1111/j.1467-9817.2010.01460.x

Linguistic Society of Hong Kong (LSHK) (1997). *Hong Kong Jyut Ping Characters Table*. Hong Kong, China: Linguistic Society of Hong Kong Press.

Liu, P. D., & McBride-Chang, C. (2010). What is morphological awareness? Tapping lexical compounding awareness in Chinese third graders. *Journal of Educational Psychology*, *102*(1), 62-73. doi: 10.1037/a0016933

Liu, P. D., McBride-Chang, C., Wong, T. T. Y., Shu, H., & Wong, A. M. Y. (2013). Morphological awareness in Chinese: Unique associations of homophone awareness and lexical compounding to word reading and vocabulary knowledge in Chinese children. *Applied Psycholinguistics*, *34*(4), 755-775. doi: 10.1017/S014271641200001X

Marcolini, S., Traficante, D., Zoccolotti, C., & Burani, C. (2011). Word frequency modulates morpheme-based reading in poor and skilled Italian readers. *Applied Psycholinguistics*, *32*, 513–532. doi:10.1017/S0142716411000191.

Marslen-Wilson, W. D., Tyler, L. K., Waksler, R., & Older, L. (1994). Morphology and meaning in the English mental lexicon. *Psychological Review*, *101*, 3-33.

Masterson, J., Stuart, M., Dixon, M., & Lovejoy, S. (2003). *Children's printed word database*. Retrieved from http://www.essex.ac.uk/psychology/cpwd/

McBride-Chang, C., Cho, J. R., Liu, H., Wagner, R. K., Shu, H., Zhou, A., ... & Muse, A. (2005). Changing models across cultures: Associations of phonological awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea, and the United States. *Journal of Experimental Child Psychology*, *92*(2), 140-160. doi: 10.1016/j.jecp.2005.03.009

McBride-Chang, C., Manis, F. R., Seidenberg, M. S., Custodio, R. G., & Doi, L. M. (1993). Print exposure as a predictor of word reading and reading comprehension in disabled and nondisabled readers. *Journal of Educational Psychology*, *85*(2), 230-238.

McBride-Chang, C., Shu, H., Zhou, A., Wat, C. P., & Wagner, R. K. (2003). Morphological awareness uniquely predicts young children's Chinese character recognition. *Journal of Educational Psychology*, *95*(4), 743-751. doi: 10.1037/0022-0663.95.4.743

McBride-Chang, C., Tardif, T., Cho, J. R., Shu, H. U. A., Fletcher, P., Stokes, S. F., ... & Leung, K. (2008). What's in a word? Morphological awareness and vocabulary knowledge in three languages. *Applied Psycholinguistics*, *29*(3), 437-462. doi:10.1017/S014271640808020X

McCutchen, D., Logan, B., & Biangardi-Orpe, U. (2009). Making meaning: Children's sensitivity to morphological information during word reading. *Reading Research Quarterly*, *44*(4), 360-376.

McGinnis, S. (1995). Student attitudes and approaches in the learning of written Chinese. Paper presented at *the Annual Conference of the American Association Applied Linguistics*, Long Beach, CA.

Nagy, W., Berninger, V. W., & Abbott, R. D. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology*, *98*(1), 134-147.

Nagy, W., Berninger, V., Abbott, R., Vaughan, K., & Vermeulen, K. (2003). Relationship of morphology and other language skills to literacy skills in at-risk second-grade readers and at-risk fourth-grade writers. *Journal of Educational Psychology, 95*, 730-742. doi: 10.1037/0022-0663.95.4.730

Nagy, W. E., Carlisle, J. F., & Goodwin, A. P. (2014). Morphological knowledge and literacy acquisition. *Journal of Learning Disability*, *47*(3), 3-12.

Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: developmental stages and processes. *Developmental Psychology*, *33,* 637-649.

Packard, J. (2000). *The morphology of Chinese: A linguistic and cognitive approach*. Cambridge, United Kingdom: Cambridge University Press.

Pasquarella, A., Chen, X., Lam, K., Luo, Y. C., & Ramirez, G. (2011). Cross-language transfer of morphological awareness in Chinese–English bilinguals. *Journal of Research in Reading*, *34*(1), 23-42. doi: 10.1111/j.1467-9817.2010.01484.x

Perfetti, C. A., Liu, Y., & Tan, L. H. (2005). The lexical constituency model: Some implications of research on Chinese for general theories of reading. *Psychological Review*, *112*(1), 43-59.

Pollatsek, A., Hyönä, J., & Bertram, R. (2000). The role of morphological constituents in reading Finnish compound words. *Journal of Experimental Psychology Human Perception and Performance*, *26*(2), 820-833.

Roman, A. A., Kirby, J. R., Parrila, R. K., Wade-Woolley, L., & Deacon, S. H. (2009). Toward a comprehensive view of the skills involved in word reading in Grades 4, 6, and 8. *Journal of Experimental Child Psychology*, *102*(1), 96-113.

Shu, H., & Anderson, R. C. (1997). Role of radical awareness in the character and word acquisition of Chinese children. *Reading Research Quarterly*, *32*, 78–89.

Shu, H., Chen, X., Anderson, R. C., Wu, N., & Xuan, Y. (2003). Properties of school Chinese: Implications for learning to read. *Child Development*, *74*(1), 27-47.

Siegel, L. S. (2008). Morphological awareness skills of English language learners and children with dyslexia. *Topics in Language Disorders*, *28*(1), 15-27. doi: 10.1097/01.adt.0000311413.75804.60

Sprenger-Charolles, L., Siegel, L. S., & Béchennec, D. (1998). Phonological mediation and semantic and orthographic factors in silent reading in French. *Scientific Studies of Reading*, *2*(1), 3-29.

Stanovich, K. E., & Cunningham, A. E. (1992). Studying the consequences of literacy within a literate society: The cognitive correlates of print exposure. *Memory and Cognition, 20*, 51-68.

Sun, H. L., Sun, D. J., Huang, J. P., Li, D. J., & Xing, H. B. (1996). The description on the corpus system of modern Chinese studies. In Z. S. Luo & S. L. Yuan (Eds.), *Studies of Chinese and Chinese character in the computer era*. Beijing, China: Tsinghua University Publisher.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics*. Boston, MA: Allyn and Bacon.

Taft, M., & Forster, K. I. (1975). Lexical storage and retrieval of prefixed words. *Journal of Verbal Learning and Verbal Behavior*, *14*, 638-647.

Taylor, B. P. (1975). The use of overgeneralization and transfer learning strategies by elementary and intermediate students of ESL. *Language Learning*, *25*(1), 73-107. doi: 10.1111/j.1467-1770.1975.tb00110.x

Tong, X., Lee, S. M. K., Lee, M. M. L., & Burnham, D. (2015). A tale of two features: Perception of Cantonese lexical tone and English lexical stress in

Cantonese-English bilinguals. *PLoS ONE*, *10*(11), e0142896. doi: 10.1371/journal.pone.0142896

Tong, X., & McBride-Chang, C. (2010). Developmental models of learning to read Chinese words. *Developmental Psychology*, *46*(6), 1662-1676. doi: 10.1037/a0020611

Tong, X., McBride-Chang, C., Shu, H., & Wong, A. M. (2009). Morphological awareness, orthographic knowledge, and spelling errors: Keys to understanding early Chinese literacy acquisition. *Scientific Studies of Reading*, *13*(5), 426-452. doi: 10.1080/10888430903162910

Tong, X., McBride-Chang, C., Wong, A. M. Y., Shu, H., Reitsma, P., & Rispens, J. (2011). Longitudinal predictors of very early Chinese literacy acquisition. *Journal of Research in Reading*, *34*(3), 315-332. doi: 10.1111/j.1467-9817.2009.01426.x

Tong, X., Tong, X., & McBride-Chang, C. (2015). A tale of two writing systems: Double dissociation and metalinguistic transfer between Chinese and English word reading among Hong Kong children. *Journal of Learning Disabilities*, 48(2), 130-145. doi: 10.1177/0022219413492854

Torgesen, J. K., Wagner, R. K., & Rashotte, C. (2011). *TOWRE-2 Test of Word Reading Efficiency.* Austin, TX: Pro-Ed.

Verhoeven, L., & Perfetti, C. A. (2011). Morphological processing in reading acquisition: A cross-linguistic perspective. *Applied Psycholinguistics*, *32*, 457-466.

Verhoeven, L., Schreuer, R., & Haarman, V. (2006). Prefix identification in the reading of Dutch bisyllabic words. *Reading and Writing*, *19*, 651-668.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *CTOPP: Comprehensive test of phonological processing*. Austin, TX: Pro-Ed.

Wang, M., & Geva, E. (2003). Spelling performance of Chinese children using English as a second language: Lexical and visual– orthographic processes. *Applied Psycholinguistics, 24*(1), 1–25. doi: 10.1017.S0142716403000018

Wang, M., Cheng, C., & Chen, S. W. (2006). Contribution of morphological awareness to Chinese-English biliteracy acquisition. *Journal of Educational Psychology*, *98*(3), 542-553. doi: 0.1037/0022-0663.98.3.542

Wang, M., Yang, C., & Cheng, C. (2009). The contributions of phonology, orthography, and morphology in Chinese-English biliteracy acquisition. *Applied Psycholinguistics, 30*(2), 291-314. doi: 10.1017/S0142716409090122

Wechsler, D. (2004). *Wechsler Intelligence Scale for Children – Fourth UK Edition: Administrative and Scoring Manual*. London, United Kingdom: The Psychological Corporation.

Yamashita, J. (2002). Mutual compensation between L1 reading ability and L2 language proficiency in L2 reading comprehension. *Journal of Research in Reading, 25*(1), 81–95. doi: 10.1111/1467-9817.00160

Yin, L., Anderson, R. C., & Zhu, J. (2007). Stages in Chinese children's reading of English words. *Journal of Educational Psychology*, *99*(4), 852-866. doi: 10.1037/0022-0663.99.4.852

Yu, P. L. (2012). *說故事學典故: 成語篇* (Learning allusion through stories: Chinese four-characters idioms) Hong Kong, China: Hok Man Publication.

Zhang, J., Anderson, R. C., Li, H., Dong, Q., Wu, X., & Zhang, Y. (2010). Cross-language transfer of insight into the structure of compound words. *Reading and Writing*, *23*, 311-336. doi: 10.1007/s11145-009-9205-7

Zhou, Y. L., McBride-Chang, C., Fong, C. Y. C., Wong, T. T. Y., & Cheung, S. K. (2012). A comparison of phonological awareness, lexical compounding, and homophone training for Chinese word reading in Hong Kong kindergartners. *Early Education & Development*, *23*(4), 475-492. doi: 10.1080/10409289.2010.530478

Table 1.

Means and Standard Deviations of Grade 2, Grade 5, and Grade 8 Children's Parent-reported Chinese and English Proficiency

Variables	Grade 2		Grade 5		Grade 8	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Parent-rated English listening comprehension	2.93	1.01	3.24	1.03	3.68	.77
Parent-rated English speaking proficiency	2.91	1.91	3.08	1.11	3.57	.80
Parent-rated English reading proficiency	2.76	1.01	3.29	1.09	3.79	.81
Parent-rated Chinese listening comprehension	4.65	.56	4.67	.62	4.78	.46
Parent-rated Chinese speaking proficiency	4.60	.66	4.63	.76	4.76	.51
Parent-rated Chinese reading proficiency	3.97	.83	4.25	.89	4.58	.62

Note. Parent-ratings were given on a 5-point Likert scale ranging from 1 (*poor*) to 5 (*excellent*).

Table 2.

Means, Standard Deviations, and F Tests for Difference Between Grade 2, Grade 5, and Grade 8 Children in Chinese Word Reading, English Word Reading, and Control Measures

Measures (Maximum possible score)	Grade 2		Grade 5		Grade 8			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	Pairwise comparisons
Non-verbal intelligence (28)	18.45	2.36	21.68	2.24	24.40	3.43	231.40***	G2 < G5 < G8
Phonological awareness (34)	14.35	6.34	18.49	6.79	25.04	7.72	92.49***	G2 < G5 < G8
Chinese vocabulary (40)	11.33	4.51	20.18	7.81	28.89	5.94	300.62***	G2 < G5 < G8
English vocabulary (36)	16.55	5.01	13.56	5.38	17.98	6.64	24.54***	G5<G2, G5<G8
Chinese word reading (150)	73.64	15.77	102.80	16.15	121.65	10.48	432.99***	G2 < G5 < G8
English word reading (174)	42.35	24.37	70.05	29.26	96.10	25.98	156.99***	G2 < G5 < G8

Note. G2 = Grade 2, G5 = Grade 5, G8 = Grade 8, ***$p < .001$.

Table 3.

Means, Standard Deviations, and F Tests for Difference Between Grade 2, Grade 5, and Grade 8 Children in Chinese and English Morphological Awareness Measures

Measures (Maximum possible score)	Grade 2		Grade 5		Grade 8			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	Pairwise comparisons
Chinese compounding awareness (24)	17.44	2.90	19.97	2.65	21.96	1.60	131.53***	G2 < G5 < G8
Chinese homophone awareness (24)	8.12	3.39	13.58	4.02	16.94	3.36	237.54***	G2 < G5 < G8
Chinese homograph awareness (30)	16.34	5.00	23.03	3.50	25.68	2.56	243.73***	G2 < G5 < G8
Chinese affix awareness (24)	16.50	4.04	20.24	2.33	21.35	1.41	125.89***	G2 < G5 < G8
Chinese semantic radical awareness (36)	19.70	6.17	24.72	6.00	26.43	5.73	52.12***	G2 < G5 < G8
English inflection awareness - analogy (24)	16.24	3.19	19.26	3.30	19.39	3.32	44.33***	G2 < G5, G2 < G8
English derivation awareness - analogy (20)	9.70	3.13	11.99	2.82	13.27	3.31	51.77***	G2 < G5 < G8
English compounding awareness - analogy (24)	21.90	2.61	23.43	1.22	21.14	4.65	20.82***	G2 < G5, G8 < G5
English inflection awareness - judgement (24)	10.36	3.77	16.98	4.43	20.16	3.97	230.16***	G2 < G5 < G8
English derivation awareness - judgement (20)	7.36	2.61	9.58	3.31	13.18	3.55	131.20***	G2 < G5 < G8
English compounding awareness - judgement (24)	14.16	3.68	15.37	4.19	19.03	4.06	62.85***	G2 < G5 < G8

Note. G2 = Grade 2, G5 = Grade 5, G8 = Grade 8, ***$p < .001$.

Table 4.

Correlations Between All Variables and Wording Reading in Grades 2, 5, and 8

	Grade 2		Grade 5		Grade 8	
Variables	CWR	EWR	CWR	EWR	CWR	EWR
Phonological awareness	.08	$.70^{***}$	$.26^{**}$	$.71^{***}$	.11	$.70^{***}$
Chinese vocabulary	$.33^{***}$	.11	$.62^{***}$	$.29^{***}$	$.48^{***}$	$.31^{***}$
Chinese compounding awareness	$.49^{***}$	$.29^{**}$	$.53^{***}$	$.31^{***}$	$.27^{***}$	$.32^{***}$
Chinese homophone awareness	$.29^{**}$	$.20^{*}$	$.70^{***}$	$.21^{**}$	$.36^{***}$	$.37^{***}$
Chinese homographic awareness	$.56^{***}$	$.28^{**}$	$.55^{***}$	$.20^{*}$	$.39^{***}$	$.29^{***}$
Chinese affix awareness	$.42^{***}$	$.19^{*}$	$.24^{**}$	.06	$.18^{*}$	.11
Chinese semantic radical awareness	$.27^{**}$	$.29^{**}$	$.36^{***}$	$.19^{*}$	$.29^{***}$	$.24^{**}$
English vocabulary	.07	$.57^{***}$	-.02	$.61^{***}$	-.05	$.72^{***}$
English inflection awareness - analogy	.15	$.39^{***}$	$.35^{***}$	$.65^{***}$	.15	$.54^{***}$
English derivation awareness - analogy	-.08	$.19^{*}$	$.22^{**}$	$.53^{***}$	$.18^{*}$	$.50^{***}$
English compounding awareness - analogy	$.20^{*}$	.09	-.04	$.18^{*}$	.03	$.30^{***}$
English inflection awareness - judgment	$.32^{***}$	$.39^{***}$	$.27^{**}$	$.56^{***}$	.12	$.52^{***}$
English derivation awareness - judgment	.14	$.36^{***}$	$.29^{**}$	$.56^{***}$	.10	$.59^{***}$
English compounding awareness - judgment	.07	.10	.08	$.48^{***}$	.13	$.54^{***}$

Note. CWR = Chinese word reading, EWR = English word reading. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 5.

Hierarchical Regression Predicting Chinese Word Reading From Age, Non-verbal Intelligence, Chinese Vocabulary, and Chinese Morphological Awareness

		Grade 2				Grade 5				Grade 8			
Step	Variables	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2
1	Non-verbal intelligence	.13	1.87	.16	$.12^{***}$	-.04	-.76	.38	$.39^{***}$	-.05	-.69	.22	$.23^{***}$
	Chinese vocabulary	.10	1.23			.31	4.64^{***}			.35	4.44^{***}		
2	Phonological awareness	-.07	-.96	.16	.00	-.03	-.51	.38	.00	-.22	-2.80^{**}	.22	.01
3	Chinese compounding awareness	.20	2.12^{*}	.37	$.27^{***}$	.12	1.73	.58	$.22^{***}$	.05	.71	.32	$.12^{***}$
	Chinese homophone awareness	.05	.71			.45	6.68^{***}			.23	2.81^{**}		
	Chinese homographic awareness	.35	3.73^{***}			.02	.24			.20	2.66^{**}		
	Chinese affix awareness	.08	.85			-.01	-.14			-.01	-.17		
	Chinese semantic radical awareness	.04	.48			.08	1.38			.08	1.08		

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 6.

Hierarchical Regression Predicting English Word Reading From Age, Non-verbal Intelligence, English Vocabulary, English Phonological Awareness and English Morphological Awareness

		Grade 2				Grade 5				Grade 8			
Step	Variables	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2
1	Non-verbal intelligence	.06	1.09	.33	$.33^{***}$	.02	.50	.39	$.39^{***}$	.03	.57	.52	$.52^{***}$
	English vocabulary	.20	2.82^{**}			.26	4.76^{***}			.39	5.58^{***}		
2	English phonological awareness	.51	7.30^{***}	.55	$.22^{***}$	.39	6.34^{***}	.62	$.23^{***}$	.34	4.93^{***}	.62	$.10^{***}$
3	English compounding awareness	-.05	-.80	.59	$.04^{**}$	.08	1.53	.70	$.08^{***}$	.01	.09	.64	$.02^{\dagger}$
	English inflection awareness	.22	3.42^{**}			.29	4.43^{***}			.09	1.11		
	English derivation awareness	-.00	-.06			.03	.34			.12	1.48		

Note. $^{\dagger}p = .057$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 7.

Hierarchical Regression Predicting English Word Reading From Age, Non-verbal Intelligence, English Vocabulary, English Phonological Awareness, English Morphological Awareness, and Chinese Morphological Awareness

		Grade 2				Grade 5				Grade 8			
Step	Variables	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2
1	Non-verbal intelligence	.07	1.29	.33	.33***	-.03	.61	.39	.39***	-.04	.81	.52	.52***
	English vocabulary	.23	3.22**			.25	4.19***			.40	5.50***		
2	Phonological awareness	.50	7.15***	.55	.22***	.41	6.46***	.62	.23***	.32	4.56***	.62	.10***
3	English compounding awareness	-.08	-1.31	.59	.04**	.09	1.57	.70	.08***	-.02	-.26	.64	.02
	English inflection awareness	.17	2.50*			.33	4.69***			.10	1.10		
	English derivation awareness	.00	-.04			.02	.29			.12	1.43		
4	Chinese compounding awareness	.10	1.71	.63	.04*	-.02	-.36	.71	.01	.07	1.06	.65	.01
	Chinese homophone awareness	.18	2.39*			.06	.89			.04	.62		
	Chinese homograph awareness	.03	.50			-.06	-1.02			-.06	-1.13		
	Chinese affix awareness	-.05	-.65			-.06	-1.26			-.01	-.18		
	Chinese semantic radical awareness	-.06	-.80			-.04	-.57			-.02	-.27		

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

Table 8.

Hierarchical Regression Predicting Chinese Word Reading From Age, Non-verbal Intelligence, Chinese Vocabulary, Chinese Morphological Awareness, and English Morphological Awareness

		Grade 2				Grade 5				Grade 8			
Step	Variables	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2	β	t	R^2	ΔR^2
1	Non-verbal intelligence	.12	1.80	.12	$.12^{***}$	-.04	-.80	.39	$.38^{***}$	-.04	-.65	.23	$.23^{***}$
	Chinese vocabulary	.10	1.35			.33	4.93^{***}			.37	4.70^{***}		
2	Phonological awareness	-.03	-.37	.12	.00	.03	.39	.39	.00	-1.7	-1.95	.24	.01
3	Chinese compounding awareness	.22	2.31^{*}	.38	$.27^{***}$	.12	1.64	.60	$.24^{***}$	.10	1.28	.35	$.12^{***}$
	Chinese homophone awareness	.05	.67			.45	6.15^{***}			.29	3.47^{***}		
	Chinese homograph awareness	.35	3.74^{***}			.03	.37			.26	3.15^{**}		
	Chinese affix awareness	.08	.95			-.01	-.12			-.04	-.54		
	Chinese semantic radical awareness	.04	.48			.08	1.31			.10	1.25		
4	English compounding awareness	.02	.23	.42	$.04^{*}$	-.17	-2.87^{**}	.63	$.03^{*}$	-.29	-2.76^{**}	.40	$.04^{*}$
	English inflection awareness	.08	.83			.08	.98			.12	1.08		
	English derivation awareness	-.22	-2.84^{**}			-.06	-.62			-.06	-.59		

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.