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Within- and cross-language contributions of morphological awareness to word reading and vocabulary in Chinese–English bilingual learners

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Abstract In this study, we investigated the contribution of morphological awareness (MA) in one language to word reading and vocabulary in another language in Hong Kong Cantonese–English speaking children, who learn Chinese and English in school in parallel from the age of 3.5 years onwards. Our sample consisted of 97 Cantonese–English speaking children including 34 first graders, 28 second graders, 21 third graders and 14 fourth graders. All children were administered tasks of nonverbal reasoning, phonological awareness in Chinese, and lexical compounding, vocabulary, and word reading in both Chinese and English. Results revealed that second language (L2) English MA significantly contributed to first language (L1) Chinese word reading and Chinese vocabulary knowledge. However, L1 Chinese MA was not uniquely associated with either L2 English word reading or vocabulary knowledge. Findings suggest that among Chinese children learning in Chinese medium of instruction schools with English taught as a second language, compounding skills in English may be useful for facilitating Chinese word reading and vocabulary acquisition, but Chinese compounding skills are not uniquely important for learning in English.

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Introduction

Children face considerable challenges to becoming biliterate in a bilingual society such as Hong Kong in which the first language (i.e., L1 Chinese) and the second language (i.e., L2 English) share few similarities in terms of linguistic features. This may make the transfer of one language to another one more difficult. The question of how bilingual children's L1 knowledge affects their reading in L2 and vice versa is of great pedagogical importance and is also of theoretical interest for bilingual children's language learning (Durgunoglu, Nagy, & Hancin-Bhatt, 1993). However, there has been relatively little research on the extent to which linguistic skills in one language can be transferred to reading in another in Chinese–English bilingual children. Most such work has focused on phonological awareness, which appears to be highly associated across Chinese and English (Chow, McBride-Chang, & Burgess, 2005; Gottardo, Yan, Siegel, & Wade-Woolley, 2001; Keung & Ho, 2008).

Morphological awareness, which is defined as the ability to access and manipulate the meaning and structure of morphemes in relation to words (Carlisle & Feldman, 1995), has been identified as a crucial linguistic factor associated with reading in monolingual Chinese- and English-speaking children (Deacon & Kirby , 2004; Ku & Anderson, 2003; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003; Shu, McBride-Chang, Wu, & Liu, 2006). However, we know relatively little about whether morphological awareness in one language could contribute to the individual variance in reading in another language in Chinese–English bilingual children. In the present study, we aimed to determine whether there is transfer of morphological awareness in one language to reading and vocabulary in another in Chinese–English bilingual children. We also looked at the within-language contribution of morphological awareness to word reading and vocabulary in Chinese–English bilingual learners to examine whether morphological awareness might be a language universal or language-specific factor that influences reading and vocabulary development.

Morphological awareness in L1 reading and vocabulary

The important role that morphological awareness plays in the development of reading skill is well documented in monolingual children across languages (Carlisle, 2010). There is widespread agreement in the literature about the predictive validity of morphological awareness in L1 reading for children as young as first grade and as old as fourth grade (Carlisle & Feldman, 1995; Deacon & Kirby, 2004), and this contribution is beyond the variance explained by other cognitive- and language-related skills. This relation is also likely to be bidirectional (Deacon, Benere, & Pasquarella, 2013). Just as morphological awareness leads to rapid reading acquisition, experience with reading seems to develop morphological awareness further (Deacon et al., 2013).

Research on morphological awareness in Chinese usually focuses on two aspects of morphological knowledge—lexical compounding awareness and homophone sensitivity. A growing number of studies have demonstrated that children's ability to understand and manipulate how morphemes can be combined legally in a language accounts for unique variance in word reading among Chinese children (e.g., Liu & McBride-Chang, 2010; McBride-Chang et al., 2003; Shu et al., 2006; Tong, McBride-Chang, Shu, & Wong, 2009). Similarly, there is compelling evidence showing that homophone sensitivity, or children's awareness that there can be multiple morphemes mapping onto one single pronunciation, is a crucial factor determining the growth of word reading development in Chinese (e.g., Liu & McBride-Chang, 2010). Children with good performance in homophone identification or production tasks tend to have a better performance in reading (e.g., Chung & Hu, 2007; McBride-Chang et al., 2003; Wang, Cheng, & Chen, 2006). The existence of a causal link from morphological awareness to reading achievement has been demonstrated by training studies in Chinese. In these studies, morphological awareness training has accelerated the pace of reading acquisition (Chow, McBride-Chang, Cheung, & Chow, 2008; Zhou, McBride-Chang, Fong, Wong, & Cheung, 2012). Collectively, research with monolingual readers convincingly identifies morphological awareness as one of the crucial components of reading across languages.

In addition to the importance of morphological awareness in word reading, morphological awareness has been suggested to be pivotal to the development of children's vocabulary (e.g., Carlisle, 2000, 2007; Kieffer & Lesaux, 2012; Sparks & Deacon, 2015). It may contribute to vocabulary development from two aspects considering the nature of vocabulary and morphological awareness. Here, vocabulary is the term for the words of a language and morphology refers to the study of the parts of words. Morphological awareness might help children develop vocabulary breadth, referring to the number of words. Children's vocabularies can expand through the processes of morphological analysis (such as decomposing words into roots, affixes, and inflectional morphemes) (Chen, Hao, Geva, Zhu, & Shu, 2009). For example, the word *careful* is composed of two morphemes: the stem *care* and the suffix *–ful.* Children who are morphologically aware understand the relationship between the base *care* and the suffix *–ful*, and how they can be combined to form the word *careful*. They could further understand the parallels of this example in which the word ends in *–ful* to others such as *helpful, useful, beautiful*, etc. At this stage, children may only have surface-level knowledge of many vocabulary words. For example, children may hear and read the word, *complicated*, and they may know it is related to something that is not simple. But children may not be able to use it correctly in writing or while speaking. Moreover, vocabulary development involves expansion of depth, referring to knowing different facets of given words such as how a word is related to other words and how to convey meaning to others. Meanwhile, morphological awareness further involves understanding the function of the component morphemes. For example, morphologically aware children know that words ending in *–ful* are usually adjectives and are generally interpreted as "characterized by." Thus, morphological awareness may help children to broaden the depth of their vocabulary knowledge (Ku & Anderson, 2003).

Empirical findings from a few studies on the association between morphological awareness and vocabulary support the hypothesis that morphological awareness is a key factor influencing children's L1 vocabulary acquisition. For example, Wagner, Muse, and Tannenbaum (2007) found a high correlation ($r = .91$) between morphological awareness and vocabulary knowledge across studies (Wagner, Muse, & Tannenbaum, 2007). Sparks and Deacon (2015) also used a longitudinal study to examine the relation between morphological awareness and vocabulary in English-speaking children. They found that children's morphological awareness at Grade 2 explained 5% of the significant unique variance in vocabulary knowledge at Grade 3 even when taking into account age, nonverbal reasoning, phonological awareness, pseudoword reading, word reading and vocabulary knowledge at Grade 2, suggesting that morphological awareness can be uniquely associated with vocabulary knowledge beyond the contribution of other cognitive and linguistic skills (Sparks & Deacon, 2015). Some studies have even suggested that the relation between morphological awareness and vocabulary knowledge is reciprocal (Ramirez, Walton, & Roberts, 2014). Similar reciprocal findings were demonstrated across a 1 year period in Cantonese, Mandarin, and Korean, respectively, in a study on kindergartners (McBride-Chang et al., 2008). However, empirical research examining the relationship between Chinese morphological awareness and vocabulary remains limited (Tong, Tong, & McBride, 2016). Nevertheless, morphological awareness contributes to growth of vocabulary for children across languages.

Morphological awareness in L2 reading and vocabulary

The question of whether the abilities in recognition and use of the smallest meaning units in one spoken language can transfer to the other language in bilingual children has attracted attention among researchers in the fields of both linguistics and reading (e.g., Koda, 2000; Pasquarella, Chen, Lam, Luo, & Ramirez, 2011; Ramirez, Chen, Geva, & Kiefer, 2010; Wang et al., 2006). In particular, it is intriguing to investigate this question in bilingual children whose L1 and L2 are two typologically distinct languages such as Chinese and English.

Chinese and English differ strongly in morphology in several ways. First, compounding is the primary way to create a new complex word in Chinese (although inflectional and derivational morphemes exist in Chinese), whereas inflectional and derivational methods are particularly important in forming new words in English (Chen et al., 2009). Second, characters are the basic written graphic units in Chinese. Each character represents both a morpheme (the smallest unit of meaning) and a syllable. In addition to this, sound, form and meaning converge within a single character. For example, the Chinese character 清 is a morpheme representing the meaning of "clear," and it is also a syllable that is pronounced in Cantonese as /ceng1/. However, in English, morphemes may refer to whole simple words such as *big* or parts of complex words such as *–ful*. Similar to

Chinese, there are also compound words in English, in which two simple words are joined together to form a new complete word (e.g., *teapot*). But most inflectional and derivational morphemes are bound morphemes that cannot stand alone; they need to be added to an existing base. Bound morphemes are traditionally classified into inflectional morphemes (e.g., the inflectional morpheme -*s* indicates plural in the word *cats*) and derivational morphemes (e.g., the derivational morpheme *–ful* has the meaning of containing a lot of something in words like *graceful*). Third, Chinese has a limited number of syllables, which leads to a great number of characters or morphemes that share an identical sound, defined as homophones. For example, the above syllable /muk6/ represents more than 3 morphemes with the same onset and vowel in Cantonese such as 木 (wood)/muk6/, 沐 (wash)/muk6/, and 目 (eye)/muk6/. Such differences between Chinese and English require researchers to examine whether transfer of morphological awareness between Chinese and English is attributable to specific morphological knowledge or related to general metalinguistic transfer.

There have been three studies to date investigating the relations between morphological awareness in one language and word reading in another language in Chinese–English bilingual children. In a study conducted by Wang, Cheng, and Chen (2006), the authors examined the transfer of morphological awareness between Chinese and English in 64 Chinese–English speaking immigrant children in the United States. Among those 64 children, 38 participants were second graders and 26 participants were fourth graders. An interesting transfer pattern was found: There was transfer from L2 English compound morphological awareness to Chinese word reading as well as Chinese reading comprehension but no transfer from L1 Chinese compound morphological awareness to English word reading. A similar transfer pattern was found in another two studies of Chinese–English bilingual children. In a study conducted by Pasquarella, Chen, Lam, Luo and Ramirez (2011), transfer from English compounding morphological awareness to Chinese reading comprehension was found in 137 first to fourth Chinese–English speaking students, who attended the school with only English language instruction for all courses. They also found no transfer from L1 Chinese morphological awareness to English reading comprehension. The third study conducted by Luo, Chen and Geva also observed that compounding morphological awareness in L2 English contributed to L1 Chinese word reading in 91 Chinese–English bilingual children; however, the contribution was indirect, through mediation of Chinese morphological awareness (Luo, Chen, & Geva, 2014).

Findings in the above studies suggest specific morphological knowledge transfer between Chinese and English in Chinese–English bilingual children, although Wang et al. (2006) argued that the transfer from English compounding awareness to Chinese reading might reflect a general form of metalinguistic awareness. However, it is worth noting that all three of the aforementioned studies of Chinese–English bilingual children were conducted in western societies in which English was the dominant language and children in those studies received schooling in English. The conclusions that can be drawn from these studies are limited by the confounding of the predominance of L1 and L2 in their schooling and family literacy patterns (Pasquarella et al., 2011). Research on this question conducted in Chinese–English bilingual children from societies where Chinese is the L1 both at home and in school might be valuable to further evaluate whether the transfer of morphological awareness between Chinese and English might be attributable to the difference in predominance of L1 and L2. Therefore, the first purpose of this study was to examine whether Chinese morphological awareness could contribute to English word reading and vice versa in Hong Kong Chinese children. We also tested these associations in vocabulary knowledge across both English and Chinese.

Although there have been several studies on the crucial role of morphological awareness in L1 vocabulary acquisition (McBride-Chang, Cheung, Chow, Chow, & Choi, 2006), there has only been one study examining how morphological awareness in Chinese or English is associated with vocabulary knowledge in Chinese or English in Chinese–English bilingual learners (Pasquarella et al., 2011). Pasquarella et al. (2011) investigated cross-language transfer of morphological awareness in Chinese–English bilingual children. Children were administered tasks of compound awareness, vocabulary knowledge, word reading and reading comprehension in Chinese and English as well as English derivational awareness, English phonological awareness, and nonverbal reasoning. Their structural equation modelling analysis revealed that (1) English compounding awareness was significantly associated with Chinese vocabulary and English derivational awareness was not a significant predictor of Chinese vocabulary; (2) there was no transfer from L1 Chinese compounding awareness to L2 English reading at either the word or text (comprehension) level; (3) Chinese vocabulary and English vocabulary were correlated with English compounding awareness; (4) English compounding awareness explained Chinese reading comprehension. The participants in this study were Chinese–English bilinguals who lived in Canada, where English is the dominant language of schooling. Therefore, the findings from this study may not generalize to all Chinese–English bilinguals. Thus, the second purpose of this study was to examine the transfer of morphological awareness in one language to vocabulary in another language.

The present study

According to the interdependence hypothesis, language transfer can occur at various aspects including transfer of metacognitive and metalinguistic strategies such as vocabulary acquisition strategies and the strength of the transfer is influenced by instruction in L1(Cummins, 2005). More specially, the interdependence hypothesis suggests that “To the extent that instruction in Lx is effective in promoting proficiency in Lx, transfer of this proficiency to Ly will occur provided there is adequate exposure to Ly (either in school or environment) and adequate motivation to learn Ly” (Cummins, 2005, p. 2). Thus, it is highly likely that Chinese–English bilingual children from western societies might transfer the strategies used in L2 English to L1 Chinese reading, which might lead to the transfer of L2 English morphological awareness to L1 Chinese word reading. Thus, findings from previous studies on the cross-language transfer of morphological awareness between Chinese and English in Chinese–English bilingual children from the United States and

Canada, in which L2 English is the dominant language, might not be able to generalize to other Chinese–English bilingual societies such as Hong Kong. Hong Kong was a perfect place, given that Chinese is the dominant language, to further explore linguistic transfer between Chinese and English in Chinese–English bilingual children. In Hong Kong, children learn Chinese and English in parallel. It is possible that children use similar strategies in English learning as in Chinese learning (Keung & Ho, 2008). Therefore, the direction and strength of morphological awareness transfer might be different from those observed in western societies.

In summary, our primary goal was to examine how morphological awareness in one language was associated with reading and vocabulary in another language in Hong Kong Chinese–English bilingual children. According to the linguistic interdependence hypothesis, linguistic skills in L1 are the foundation for L2 acquisition, and a transfer is usually predicted from the strong L1 to the weak L2; a bidirectional transfer is anticipated additionally when there is adequate exposure to both L1 and L2 (Koda, 2005). In our study, children were first to fourth graders, who had learned Chinese and English in parallel since age 3.5 years old. Cross-language transfer was thus expected between morphological awareness in one language and both reading and vocabulary in the other language based on the linguistic interdependence hypothesis and prior findings. Moreover, we also sought to examine whether the robust within-language contribution of morphological awareness to word reading and vocabulary in monolingual children could be observed in Chinese–English bilingual learners. In addition, we tested children's phonological awareness in this study, but only in Chinese. We assumed that there would be strong transfer from L1 Chinese phonological awareness to English literacy based on prior studies in Chinese–English bilingual children (Gottardo et al., 2001; McBride-Chang et al., 2006; Wang, Perfetti, & Liu, 2005).

Method

Participants

The sample comprised 97 Chinese–English bilingual children (48 female and 49 male) including 34 first graders, 28 second graders, 21 third graders and 14 fourth graders. The mean age was 93.91 months (SD = 13.91). Those 97 children were selected from a three-year longitudinal twins' study in Hong Kong. One child was randomly selected from each pair of (either identical or fraternal) twins from among 97 pairs. The data of only Year 1 were used in the following analyses. All of the children were native Cantonese speakers who had learned English as a second language since age 3. Cantonese Chinese was the medium of instruction in their schools. These children were drawn from 58 different primary schools all over Hong Kong.

Measures

Nonverbal reasoning ability

Raven's Progressive Matrices were adopted to test children's nonverbal reasoning ability. These included five sets of items from A to E. Following the norm of the Hong Kong supplement to guide to the Standard Progressive Matrices (Education Department, 1986), children aged below 8.5 years old were only required to complete sets A–C while those who aged above 8.5 years old completed all five sets. The purpose for this was simply to shorten the testing time for younger participants. For each test item, children were required to select a piece from among six to eight choices which completed the missing part of a visual matrix. One point was given for each correct response. The maximum score of this test was 45 for children below 8.5 years and 60 for children above. The internal consistency reliability for this test was .84.

Chinese phonological awareness

This task consisted of two parts, namely, syllable deletion and phoneme deletion. For the syllable deletion section, there were 4 practice items and 29 test items arranged in three levels with increasing difficulty (9–10 items in each level). In this part, children were required to take away one syllable from three-syllable words or pseudowords in Chinese. For example, the word syllable sequence "*fo2(火)* ce1(車) zaam6(站)" (*train station*) without "zaam6"(*station*) becomes "fo2 ce1" (*train*) while in the pseudoword syllable sequence "gwit4 joe2 kaap6" without "gwit4" becomes "joe2 kaap6". For the phoneme deletion part, there were 4 practice items and 22 test items arranged in another three difficulty levels (7–8 items in each level). Here, children were required to say one to three syllable words or pseudowords aloud, but without saying the initial phoneme. For example, the one syllable word *燈/dang1/* without the initial sound would be */ang1/* while the three syllable pseudoword "gwit4 joe2 kaap6" without the onset would be "wit4 oe2 app6." Basal and ceiling rules were applied in both parts. Children started at a level that matched their grade level, and testing stopped if they got 2–5 (for syllable deletion part) and 2–3 (for phoneme deletion) wrong answers in one of the levels, respectively. One point was given for each correct response. The maximum possible score of the entire task was 51. The internal consistency reliability for this test was .96.

Chinese morphological awareness

We used both a morphological construction task and a compounding production task to examine children's ability to manipulate Chinese morphological structure. These tasks have been successfully used in prior studies measuring Chinese children's morphological awareness (e.g., Liu & McBride-Chang, 2010; McBride-Chang et al., 2003). In the morphological construction task, there were 2 practice items and 27 test items. Items were arranged in 5 grade levels (i.e., Kindergarten 3, Grades 1, 2, 3, and 4 according to item difficulty (5–7 items in each level). Children started at a level matching their grade level and testing stopped once the child gave 2–3 wrong responses in one of the levels. One point was given for each correct answer. Children were orally presented with a scenario that describes one object or concept for each item. Children were required to create a newly described object or concept based on a description. For example, "由一隻蜘蛛織成嘅網, 我哋會叫佢做蜘蛛網，咁由一隻螞蟻織成嘅網, 我哋會點叫佢呀?" (The webs that are made by spiders are called spider webs. What would we call the webs that are made by ants? The correct answer for this item should be "ant webs")". In the compounding production task, children were asked to make up a word which best describes the newly created object presented in a scenario without being given hints on the morphological structure. For example, "一隻會捉昆蟲嘅貓叫做咩野?" (What should we call a cat that catches bugs?) The model answer was 捉蟲貓 (*bug-catching cat*). There were 2 practice items and 21 test items, and the test was modeled after the one used by Chung et al. (2008). One point was given for each correct response. The internal consistency reliability for this test was .93.

Chinese vocabulary knowledge

This task consisted of three parts including Chinese receptive vocabulary, expressive vocabulary and vocabulary definitions. For the receptive vocabulary part, the experimenter said a Chinese word and asked the children to select a picture from among four which best represented the word they just heard. For the expressive vocabulary part, children were asked to name a given picture in Chinese (e.g., dog, writing, etc.). All picture stimuli were extracted from the Peabody Picture Vocabulary Test-Third Edition (PPVT-III; Dunn & Dunn, 1997). The Chinese receptive and expressive vocabulary sections were administered together, with the receptive one coming first. There were 10 and 12 test items in the receptive and expressive vocabulary parts, respectively. One point was given for each correct response. Testing stopped when a child scored 5 wrong answers consecutively. For the vocabulary definitions task, experimenters orally presented a Chinese word that represented a concept or an object to the children individually. Children were then asked to define the word orally. We used a 0- to 2-point standardized marking scheme to score children's answers. Zero points were given for no answer or a clearly wrong answer and a score of 2 was given for a clear description of the target word. There were 26 test items and testing stopped once the children scored 0 on five consecutive items. The internal consistency reliability for this test was .91.

Chinese word reading

A standardized measure was adopted from the Chinese Word Reading subtest of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing for Primary School Students-Second Edition (HKT-P[II]; Ho, Chan, Chung, Tsang, Lee, & Cheng, 2007). There were 150 two-character Chinese words as test items. The words were arranged in order of ascending difficulty. Children were required to read aloud the words one by one. Testing stopped once the child failed to read 15 consecutive items. One point was awarded to each correctly read word. The maximum score of this task was 150. The internal consistency reliability for this test was .93.

English morphological awareness

A single task which included two sections was designed to test children's morphological awareness in English. The first section, morpheme compounding, was similar to that used by McBride-Chang et al. (2005) for testing the morphological awareness of children in the United States. This part consisted of 4 trial items and 11 test items. Children were first orally presented an example of how an English compound word was made ("*Dishwasher* is a machine that you use to wash dishes"). and then they were required to create a new word based on the example given ("What should we call the machine that we use to wash *spoons*?"). The correct answer should be "Spoonwasher." One point was awarded for each correct response. The second section was adopted from Liu and McBride-Chang's (2010) compounding production task, and it included 5 test items. The task was similar to that used for tapping children's morphological awareness in Chinese. However, children were asked to make up a word in English this time. For example, "What do we call a monster that only eats pizza?" The model answer was *pizza-eating monster*. Answers were rated on a 0- to 4-point scale according to the rationale given in the study of Liu and McBride-Chang (2010). Thus, the maximum possible score of this part was 20. The internal consistency reliability for this test was .77.

English vocabulary

A task which is similar to the one we used for tapping children's Chinese vocabulary knowledge was administered to assess children's English vocabulary knowledge. The task included three parts, i.e., English receptive vocabulary, expressive vocabulary and vocabulary definitions. All test items were in English. There were 21, 23 and 26 test items for the receptive and expressive and vocabulary definition parts, respectively. Children were asked to stop once they gave five incorrect responses respectively. The English vocabulary definitions part was made up of 15 English vocabulary items arranged in an order of increasing conceptual difficulty. Each English vocabulary word was presented to the children in spoken form and they were asked to explain the meaning of that word. A 0- to 2-point standardized marking scheme was adopted to score children's answers. No answer or an obviously wrong answer was scored as 0 while a comprehensive description of the target word was scored as 2. A 0.5 mark was given for a correct Chinese translation of the English vocabulary word. The rationale for this coding scheme was that if children could translate an English word into Chinese, it reflected their ability to understand the word, but they were not sufficiently strong in English to explain it. The strongest skill would be both to understand the word in English and to explain it in English. The maximum possible score of this part was 30. The same stopping rule applied in the vocabulary definition part. That is, children were allowed to stop if they provided five successive wrong answers. The internal consistency reliability for this test was .94.

English word reading

The English word reading test used in the present study was based on the one used by Tong and McBride-Chang (2010). Ten easy items were deleted from the list and thus the test consisted of 50 English words in total. All words were selected from English textbooks used in Hong Kong kindergartens and primary schools. The test items were arranged in 5 levels according to reading difficulty. One point was given for each correct answer. Testing stopped once the child answered 4 consecutive items incorrectly at one level. The internal consistency reliability for this test was .98.

Procedure

Children were tested individually either in a University center or at their home or at their school depending upon their parents' preference. Testing was conducted by trained research assistants or student helpers who were undergraduate psychology majors. All tests were administered in a single session. A token of appreciation was given after the testing to express our gratitude for their participation.

Results

Descriptive statistics and interrelations among measures

Table 1 shows the descriptive statistics of all measures. Reliabilities for all measures were above .70, i.e., within an acceptable range. Vocabulary for each language was measured using three separate subtests for each language. We did this in order to allow for a wide range of language competencies, from receptive to basic expressive (one word answers), in which children's ability to explain concepts was assessed. We conceptualized the subtests as basically tapping the same underlying construct

Table 1 Descriptive statistics across measures

Measures	Range	Mean	SD
Age (months)	71–130	93.91	13.91
Raven's (nonverbal IQ)	7–49	29.05	9.39
Chinese phonological awareness	17–51	34.51	10.22
Chinese morphological awareness	7–40	20.60	7.13
Chinese vocabulary	7–49	22.15	8.12
Chinese word reading	1–145	81.51	34.32
English morphological awareness	0–27	15.78	5.24
English vocabulary	2.5–47	22.77	10.80
English word reading	0–48	21.20	15.10

of vocabulary knowledge for each language given that the three subtests for each language were moderately correlated with each other. In addition, we performed a factor analysis that included the three subtests for both L1 and L2, and the results showed that only one factor emerged with Eigenvalue $\lambda = 2.07$ and 2.47 for Chinese and English, respectively; these were at acceptable levels ($\lambda > 1.0$). This factor explained 69.0 and 82.4% of the variance in total of the vocabulary for L1 Chinese and L2 English, respectively. Therefore, the sum of the subtests was used to represent vocabulary knowledge for each language.

Table 2 shows the correlations among all measures and age and grade level. Chinese morphological awareness moderately correlated with Chinese word reading and Chinese vocabulary. The magnitudes of the correlations between Chinese morphological awareness and English word reading and vocabulary were relatively weak, though statistically significant. However, English morphological awareness moderately correlated with Chinese word reading and it strongly correlated with Chinese vocabulary. English morphological awareness also moderately correlated with English word reading and vocabulary.

As shown in Table 2, age and grade level moderately correlated with Chinese vocabulary and word reading and also significantly correlated with English vocabulary and word reading, suggesting that age and grade level might be two factors that influence the strength of the relations among morphological awareness, word reading, and vocabulary. Thus, a partial correlation analysis was conducted to further examine the correlations among all variables. Table 3 shows the partial correlations of all measures, statistically controlling for the effects of age and grade levels. Noteworthy from the partial correlation analyses are the significant correlations of Chinese morphological awareness with all other Chinese and English measures. Similarly, English morphological awareness was also significantly correlated with English word reading and vocabulary as well as with all Chinese measures. Moreover, Chinese phonological awareness had significant associations with all measures in both Chinese and English. In particular, the partial correlations between Chinese phonological awareness and English word reading and vocabulary were at a moderate level.

Examining the contribution of morphological awareness in Chinese and English to Chinese word reading and vocabulary

Two multiple regression analyses were performed to investigate the within- and cross-language contributions of morphological awareness to Chinese word reading and vocabulary. Phonological awareness in Chinese was also entered into the regression analyses for English within-language models. The results are shown in Table 4.

In the first regression analysis, we examined the roles of Chinese phonological awareness, morphological awareness and English morphological awareness in Chinese word reading. Age, grade level and nonverbal reasoning ability were entered into the first block as control variables. Chinese phonological awareness was entered in the second block. This variable made a contribution of 1.2% to Chinese word reading. Chinese morphological awareness was entered into the third block,

Table 2 Correlations among all variables

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Age	–															
2	Grade	.92***	–														
3	Raven's	.74***	.66***	–													
4	Chinese PA	.35**	.35***	.47***	–												
5	Chinese MA	.56***	.55***	.55***	.53***	–											
6	Chinese RV	.50***	.47***	.61***	.37***	.44**	–										
7	Chinese EV	.55***	.48***	.57***	.32**	.48***	.60***	–									
8	Chinese VD	.69***	.71***	.60***	.39***	.54***	.47***	.53***	–								
9	Chinese VT	.73***	.72***	.69***	.43***	.60***	.68***	.77***	.94***	–							
10	Chinese WR	.74***	.74***	.69***	.48***	.64***	.56***	.65***	.71***	.78***	–						
11	English MA	.38***	.37***	.51***	.42***	.47***	.46***	.52***	.46***	.55***	.54***	–					
12	English RV	.03	−.01	.23*	.48***	.12	.24*	.14	.15	.19	.19	.50***	–				
13	English EV	.01	.01	.24*	.39***	.15	.25*	.09	.08	.12	.11	.43***	.75***	–			
14	English VD	.18	.16	.36***	.50***	.33**	.40***	.32**	.32**	.39***	.34**	.58***	.73***	.73***	–		
15	English VT	.09	.07	.32**	.51***	.23*	.34**	.22*	.22*	.28**	.25*	.57***	.90***	.89***	.92***	–	
16	English WR	.36**	.36***	.48***	.63***	.40***	.43***	.37***	.38***	.45***	.52***	.59***	.68***	.73***	.78***	.81***	–

PA phonological awareness, *MA* morphological awareness, *RV* receptive vocabulary, *EV* expressive vocabulary, *VD* vocabulary definition, *VT* vocabulary in total, *WR* word reading

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

Table 3 Partial correlations among all variables, controlling for age and grade level

Variables		N	1	2	3	4	5	6	7	8
1	Raven's (nonverbal IQ)	97	–							
2	Chinese PA	94	.35**	–						
3	Chinese MA	97	.25*	.40***	–					
4	Chinese vocabulary	97	.38***	.28**	.35**	–				
5	English MA	96	.39***	.33**	.32**	.43***	–			
6	English vocabulary	97	.39**	.52***	.21*	.33**	.58***	–		
7	Chinese word reading	96	.33**	.33**	.37**	.52***	.41***	.29**	–	
8	English word reading	97	.38***	.57***	.22*	.30**	.52***	.83**	.40***	–

PA phonological awareness, *MA* morphological awareness

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

Table 4 Regression analyses explaining Chinese word reading and vocabulary using Chinese phonological and morphological awareness and English morphological awareness statistically controlling for age, grade level and Raven's

Step	Variables	Chinese word reading					Chinese vocabulary				
		β	*t*	R^2	ΔR^2	ΔF	β	*t*	R^2	ΔR^2	ΔF
Step 1	Age	.06	.32	.61	.61	45.79***	.10	.52	.61	.61	46.12***
	Grade level	.47	2.8**				.38	2.31*			
	Raven's (nonverbal IQ)	.33	3.30**				.38	3.83***			
Step 2	Chinese PA	.17	2.30*	.63	.02	5.31*	.13	1.66	.62	.01	2.76
Step 3	Chinese MA	.21	2.48*	.66	.02	6.13*	.19	2.26*	.64	.02	5.13*
Step 4	English MA	.18	2.34*	.68	.02	5.45*	.21	2.70**	.67	.03	7.29**

PA phonological awareness, *MA* morphological awareness

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

where it explained 2.1% of the total variance in Chinese word reading. English morphological awareness was entered in the fourth block. English morphological awareness made a contribution of 2.8% to Chinese word reading.

The second regression analysis, on the associations among Chinese vocabulary, Chinese phonological awareness and morphological awareness and English morphological awareness, showed that the contribution of Chinese phonological awareness to Chinese vocabulary was below the conventional level of significance. However, Chinese morphological awareness made a significant contribution of

2.1% to Chinese vocabulary. Moreover, English morphological awareness significantly explained 2.8% of the total variance in Chinese vocabulary knowledge.

Examining the contribution of morphological awareness in Chinese and English to English word reading and vocabulary

Another two sets of multiple regression analyses were performed to examine the contributions of Chinese phonological awareness and morphological awareness and English morphological awareness to English word reading and vocabulary. Given the fact that English morphological awareness was not measured in this study, only phonological awareness in Chinese was entered into the regression analyses for English within-language models.

In the first regression analysis, we examined the extent to which those variables contribute to English word reading. As shown in Table 5, age, nonverbal reasoning ability and grade level were first entered into the model. Chinese phonological awareness was entered in the second block. Chinese phonological awareness explained 18.6% of the total variance in English word reading. English morphological awareness was entered in the third block and it explained 8.4% of the total variance in English word reading. In the fourth block, Chinese morphological awareness was entered into the model. The R^2 change was not significant, suggesting there might not be transfer from Chinese morphological awareness to English word reading.

Similar results were found in the second regression analysis, in which the contributions of Chinese phonological awareness and morphological awareness and English morphological awareness to English vocabulary were examined. In this analysis, Chinese phonological awareness made a contribution of 16.5% to English vocabulary and English morphological awareness made a unique contribution of 14.9% to it. However, the R^2 change was not significant for the contribution from Chinese morphological awareness to English vocabulary.

Discussion

The goal of this study was twofold. First, we aimed to replicate the findings found in first language research that morphological awareness is crucial to reading and vocabulary knowledge in Chinese–English bilingual learners. Second, we sought to determine the cross-language contribution of morphological awareness in one language to word reading and vocabulary in the other language in Chinese–English bilingual learners in the Hong Kong setting. Findings from the present study demonstrate that morphological awareness plays an important role in reading and vocabulary in each language in bilingual children. Moreover, we found that L2 English morphological awareness significantly contributed to the variance in L1 Chinese word reading and vocabulary in Chinese–English bilingual children in Hong Kong, where Chinese is used as a medium of instruction in schools and English is taught as a second language. In contrast, L1 Chinese morphological

Table 5 Regression analyses explaining English word reading and vocabulary using English morphological awareness statistically controlling for age, grade level, Raven's (nonverbal IQ) and Chinese phonological awareness

Step	Variables	English word reading					English vocabulary				
		β	*t*	R^2	ΔR^2	ΔF	β	*t*	R^2	ΔR^2	ΔF
Step 1	Age	−.32	−1.25	.26	.26	10.34***	−.36	−1.32	.16	.16	5.68**
	Grade level	.30	1.33				.01	.05			
	Raven's (nonverbal IQ)	.53	3.93***				.58	4.03***			
Step 2	Chinese PA	.49	5.43***	.44	.19	29.45***	.47	4.64***	.33	.17	21.51***
Step 3	English MA	.35	3.93***	.53	.08	15.47***	.46	4.96***	.47	.15	24.58***
Step 4	Chinese MA	−.12	−1.21	.54	.01	1.47	−.14	−1.33	.49	.01	1.76

PA phonological awareness, *MA* morphological awareness

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

awareness was not a significant contributor to L2 English word reading and vocabulary in these children.

Previous findings have highlighted the fact that Chinese morphological awareness is important for both word reading and vocabulary knowledge in Chinese (e.g., McBride-Chang et al., 2006, 2008; Shu et al., 2006). We also found that English morphological awareness made a significant contribution to English word reading. The within-language contribution of morphological awareness likely facilitates children's reading development in at least two ways (Chen et al., 2009). First, morphological awareness helps children to understand the structure of morphologically complex words. Second, morphological awareness assists children in assessing the meaning of morphologically complex words by analyzing the meaning of the morphemes that children have already acquired.

Cross-language transfer was also revealed in the present study. That is, English morphological awareness made a significant contribution to Chinese word reading in Hong Kong Chinese–English bilingual children. This finding is in accord with results reported by Wang et al. (2006) on the cross-language morphological awareness transfer between Chinese and English in Chinese–English bilingual children in an American setting. However, the variance of L1 Chinese word reading explained by L2 English morphological awareness in the study by Wang et al. (2006) was larger than that observed in the present study. That is, 2.1% total variance of L1 Chinese word reading was explained by L2 English morphological awareness in the present study. Wang and colleagues reported that 4.1% of the total variance in L1 Chinese character reading was explained by L2 English compounding morphological awareness. This may be because the contributions from Chinese phonological awareness and morphological awareness as well as age, grade and nonverbal reasoning were all controlled in our study. In the Wang et al. (2006) study, they only controlled English phoneme awareness, but did not control for Chinese phonological awareness or morphological awareness. These two variables were significantly associated with English morphological awareness in our partial correlational analyses. In fact, we found that 4.4% of the total variance in Chinese word reading could be explained by L2 English morphological awareness if the contributions from Chinese morphological and phonological awareness had not been partialled out in the present study.

Wang et al. (2006) suggest that the transfer from L2 English morphological awareness to L1 Chinese reading observed in their study might be attributable to the relatively fast development of L2 English language skill in their Chinese–English bilingual children. The authors argued that participants in their study had heavy exposure to English learning due to the fact that English was the medium for school instruction during weekdays. Thus, those children in their study may have adopted strategies acquired in their L2 English learning in processing their L1 Chinese. In other words, the authors maintained that L2 English became their dominant language as a result of the intensive L2 language environment. Thus, morphological awareness can be transferred from a strong language to a weak language. It was then expected that L2 English morphological skill would contribute to L1 Chinese reading. Interestingly, we found the same transfer pattern in Hong Kong Chinese–English bilingual children whose L1 Chinese was the dominant language.

Therefore, the unidirectional transfer from English morphological awareness to Chinese reading may not have been caused only by the predominance of the language used in their schooling.

Pasquarella et al. (2011) found a similar pattern of only a contribution from L2 English compounding awareness to L1 Chinese reading comprehension but no transfer from L1 Chinese compounding awareness to L2 English reading comprehension. The authors proposed that this finding may suggest that the contribution of morphological awareness from one language to reading in another language may be associated with the morphological features of the two languages. For example, compounding is the primary way in which Chinese creates new words; in contrast, compounding awareness is not as important in English as it is in Chinese. In English, there are more derivational and inflectional morphemes. Thus, it is plausible that one might expect some association of L2 English compounding skill to L1 Chinese reading but not vice versa. This hypothesis somewhat supports the one-way transfer from English morphological awareness to Chinese reading observed in Hong Kong Chinese–English bilingual children in the present study.

In addition to the within- and cross-language contributions of morphological awareness to word reading, morphological awareness was also associated with vocabulary development in Chinese–English bilingual children. There was robust evidence of a within-language contribution of morphological awareness to vocabulary development in each language even accounting for the effects of word reading of the language, nonverbal reasoning, age and grade level. This finding is consistent with the well-documented role of morphological awareness for vocabulary development in both English and Chinese (McBride-Chang et al., 2008; Sparks & Deacon, 2015). As mentioned above, morphological awareness contributes to vocabulary development in two ways. First, awareness of a word composed of two or more morphemes facilitates children's learning of new words (Chen et al., 2009). Second, morphological awareness helps children to directly or indirectly derive meanings of words through fostering comprehension of the small parts that they are familiar with (Ku & Anderson, 2003).

L2 English morphological awareness not only predicted Chinese word reading, but it also explained 2.8% of the total variance in Chinese vocabulary in the present study. This finding is in agreement with the results of the study conducted by Pasquarella et al. (2011), in which they observed transfer from L2 English compounding awareness to L1 Chinese vocabulary in Chinese–English bilingual learners in a Canadian setting; there was no transfer from L2 English derivational awareness to L1 Chinese vocabulary. As argued by Pasquarella and colleagues, the transfer of morphological awareness in one language to vocabulary in another language is determined by the morphological features of the language of the dependent variables. That is, compounding awareness is crucial to creating new vocabulary words in Chinese, but compounding awareness is not the primary way to form new words in English. Therefore, the compounding awareness in Chinese may not be important to the development of L2 English vocabulary.

An alternative possibility for the unidirectional contribution only from English morphological awareness to Chinese word reading and vocabulary is that the compounding awareness in English may be language-universal, and this may be susceptible to cross-linguistic transfer in bilingual learners. In contrast, compounding ways in Chinese tend to be fairly language-specific. From a linguistic perspective, for example, the majority of compound words in English are "right-headed," meaning that the more important or focal word is on the right side such as *snowstorm* (Ceccagno & Basciano, 2007). In *snowstorm*, *storm* is the focal word. However, linguists suggest that Chinese appears to have three different compounding patterns: right-headed such as 公示 (public-show), left-headed such as 攀高 (climb + high) and two-headed such as 靓丽 (bright +beautiful) (Ceccagno & Basciano, 2007). To test this hypothesis, bilinguals with English as a second language but with different L1s such as Chinese–English bilinguals, Chinese-French bilinguals, and English-French bilinguals should be included in one study and their compounding abilities in both their L1 native language and L2 English should be assessed in parallel. If English compounding is language-universal, the transfer then from L2 English compounding can be observed in all groups with different L1s. But the Chinese compounding awareness should not be able to predict reading ability either in French or in English if it is language-specific. A secondary point in the unequal association of morphological awareness to reading across languages is that whereas the Chinese morphological awareness measure consisted exclusively of compound words, the English one tapped not only children's compounding but also their ability to derive inflections and derivations. Such skills are minimally important in Chinese, which has very few such characteristics. That is, inflections or derivations in Chinese are relatively rare. Perhaps because the English morphological awareness test was so eclectic, it failed to capture the shared variance between vocabulary knowledge in Chinese and morphological awareness in English.

There is another interesting finding that is worth highlighting in this study. Our results revealed that Chinese phonological awareness not only showed a significant contribution to Chinese word reading, but it also made significant contributions to English word reading and English vocabulary. This finding is in accord with prior studies in Chinese–English bilingual children (e.g., Gottardo et al., 2001; McBride-Chang et al., 2006; Wang et al., 2005), highlighting apparently strong transfer from L1 Chinese phonological awareness to English literacy. We had assumed such transfer, which is why we tested phonological awareness in Chinese only, thinking that it was not necessary to test it in English as well. Importantly, the contribution of Chinese phonological awareness to English word reading and vocabulary was much larger in comparison to its contribution to Chinese word reading. This finding further supports our hypothesis that transfer from one language to another might be determined by the characteristics of that language. For example, English is a language in which phonological awareness is crucial to literacy development. In contrast, the role of phonological awareness in Chinese is not as important as it in English.

This study was somewhat limited given that the study made use of mixed age children (i.e., Grades 1–4). The sample size for each grade was small, which limited us in examining morphological awareness transfer by grades. Thus, we could not make strong claims about developmental patterns of morphological awareness transfer in Chinese–English bilingual children. As speculated by Deacon and colleagues, the cross-language transfer of morphological awareness in a single direction may occur at certain learning stages, perhaps at the earliest and more advanced grades (Deacon et al., 2007). It might be of theoretical interest to track the developmental changes of the role of morphological awareness in one language to reading in another in Chinese–English bilingual children by designing a longitudinal study in future work.

In summary, the substantial within-language contribution of morphological awareness to word reading and vocabulary revealed in the present study highlights the importance of morphological awareness in the development of reading and vocabulary acquisition in Chinese–English bilingual children. This suggests that morphological awareness is a language-universal factor that influences both word reading and vocabulary in children. Moreover, the unidirectional transfer from L2 English morphological awareness to L1 Chinese word reading and vocabulary observed in the Hong Kong setting combined with results in prior studies in Chinese–English bilingual in western settings suggests that the transfer from one language to another depends not only the proficiency of L1 and L2, but also the characteristics of the two languages involved. Understanding how learning and instructional environments influence the strength and direction of such transfer may have important implications for reading assessment and instruction of Chinese–English bilingual children.

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