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Chinese-English biscriptal reading: cognitive component skills across orthographies

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Abstract This study examined the associations of Chinese visual-orthographic skills, phonological awareness, and morphological awareness to Chinese and English word reading among 326 Hong Kong Chinese second- and fifth-graders learning English as a second language. Developmentally, tasks of visual-orthographic skill, phonological awareness, and morphological awareness improved with age. However, the extent to which each of the constructs explained variance in Chinese and English word reading was stable across age but differed by orthography. Across grades, visual-orthographic skills and morphological awareness, but not phonological awareness, were uniquely associated with Chinese character recognition with age and nonverbal IQ statistically controlled. In contrast, Chinese visual-orthographic skills and phonological awareness, but not morphological awareness, accounted for unique variance in English word reading even with the effects of Chinese character recognition and other reading-related cognitive tasks statistically controlled. Thus, only visual-orthographic skills appeared to be a consistent factor in explaining both Chinese and English word reading, perhaps in part because Hong Kong Chinese children are taught in school to read both Chinese and English using a "look and say" strategy that emphasizes visual analysis for word recognition. These findings extend previous research on Chinese visual-orthographic skills to English word reading and underscore commonality and uniqueness in bilingual reading acquisition.

Keywords Visual-orthographic skills · Bi-scriptal reading · Hong Kong Chinese children · Phonological awareness · Morphological awareness

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Introduction

Learning to read is a process underpinned by a variety of cognitive and metalinguistic skills (Adams, 1990; Ziegler & Goswami, 2005) and its route is shaped by the characteristics of a given writing system (e.g., Bialystok, Majumder, & Martin, 2003; Frith, Wimmer, & Langerl, 1998) and specific educational practices (e.g., Leong, Hau, Cheng, & Tan, 2005; Shu, Chen, Anderson, Wu, & Xuan, 2003). Recent research on word reading has revealed that phonological awareness, morphological awareness, and orthographic knowledge are important factors in word reading across alphabetic languages (e.g., Carlisle, 1995; Foorman, 1994; Wagner et al., 1997) and nonalphabetic languages (e.g., Ho & Bryant, 1997; McBride-Chang & Ho, 2000; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003), and their importance to word reading might well vary across languages (e.g., Deacon, Wade-Woolley, & Kirby, 2007; Koda, 2000). Evidence from cross-language and cross-orthography studies has also suggested that learning two different languages might reinforce children's sensitivity to these metalinguistic or cognitive skills (e.g., Leong, et al., 2005). In this study, we examined the extent to which metalinguistic or cognitive skills specific to a given script can extend their effects to learning to read a sharply contrasting script. Specifically, we investigated the roles of Chinese visual-orthographic skills, phonological awareness, and morphological awareness for biscriptal reading development among Hong Kong Chinese children learning English as a second language.

Variation in reading Chinese and English

A growing body of evidence on monolingual and cross-lingual reading has suggested that some variation in reading processes across languages is attributable to different requisite skills necessary for learning to read in different languages and orthographies (e.g., Cheung, Chen, Lai, Wong, & Hills, 2001; Gottardo, Yan, Siegel, & Wade-Woolley, 2001; Wang, Perfetti, & Liu, 2005). A comparative analysis on the process of word reading across Chinese and English can perhaps highlight some variations in the routes by which learning to read develops across orthographies. Chinese is a morphosyllabic system (Mattingly, 1992) in that the syllable is a strongly salient spoken unit mapped onto the character, a basic unit in written Chinese, while the phoneme cannot be represented in written Chinese. Moreover, substantial experimental evidence accumulated in recent years has demonstrated that the syllable is a particularly reliable phonological unit in explaining early success in Chinese word reading (e.g., McBride-Chang & Ho, 2000; McBride-Chang, Bialystok, Chong, & Li, 2004; McBride-Chang, Tong, Shu, Wong, Leung, & Tardif, 2008). In contrast, a somewhat coherent link between the spoken unit (phoneme) and the unit of print (letters) makes the phoneme-size unit much more representative for English, and children's abilities to manipulate phonemic units tend to be strongly linked with word reading in this language (Treiman & Zukowski, 1996).

Apart from phonological awareness, Chinese also contrasts with English in terms of orthographic and morphological aspects. In Chinese, the basic writing unit is the

character, which is quite different from English linear alphabetic writing. Chinese characters consist of strokes, all laid out in square shape patterns, emphasizing visual structure and configurations. Moreover, approximately 90% of Chinese characters are compound characters (Li, 1993), i.e., composed of separate stroke patterns or components with different visual patterns and functions (signifying meaning and sound, respectively). Hence, one of the requisite skills for learning to read Chinese is visual-orthographic skill, as demonstrated in previous studies on Chinese literacy skills (Ho, Yau, & Au, 2003; Shen & Bear, 2000). The strong association of visual-orthographic processing with Chinese word reading was demonstrated in work by Ho, Yau and Au (2003), using a pseudoword spelling task that assessed children's understanding of positional and functional regularities of Chinese radicals. Children's performance on this task was strongly related to their Chinese word reading performance, a result highlighting the importance of mastery of orthographic knowledge. There is also evidence that visual discrimination and memory measures are associated with Chinese word reading across both Taiwan and Hong Kong Chinese samples (Huang & Hanley, 1995). How visual-orthographic skills are conceptualized and tested may, in part, affect how these skills are related to reading in Chinese and English.

Chinese also makes greater use of different aspects of lexical compounding and homophone awareness, two facets of morphological awareness, than does English. Lexical compounding is often used to form complex words in Chinese. Moreover, the semantic structures of the formed words are relatively transparent. For example, a single Chinese character meaning *tea* can be composed of a four-character compound word such as *jasmine tea* or *cold lemon tea*. The meanings of both these compound words can be derived from the single character representing *tea*. Hence, the salient semantic transparency of formed words facilitates children to access the meaning of unknown words based on given known words. In addition, Chinese has a large number of homophones. An essential goal of Chinese children learning to read is to distinguish homophones across words. To be sensitive to the meaning of an identical syllable across word contexts and visual discrimination patterns of different characters are the primary strategies used by Chinese children. Of these, the meaning-based word context strategy is most commonly used. Given the morphologically based nature of Chinese, morphological awareness tends to be strongly correlated with Chinese word reading performance across beginning and advanced readers, as demonstrated in past studies (e.g., McBride-Chang et al., 2003; Shu, McBride-Chang, Wu, & Liu, 2006). English is not completely alphabetic, and its print units convey semantic relationships and exact sound information simultaneously (Chomsky & Halle, 1968; Nagy, Berninger, & Abbott, 2006). However, there is evidence that morphological awareness explains unique variance in English word reading (e.g., Deacon & Kirby, 2004), as well as in reading comprehension, reading vocabulary, spelling, and decoding morphological complex words (e.g., Nagy et al., 2006). Interestingly, the association of morphological awareness to word reading, spelling, and reading comprehension in English was particularly persistent among second-grade less competent readers in one study (Nagy, Berninger, & Abbott, 2003).

Recent studies have demonstrated crossover effects of morphological awareness on biliteracy acquisition (e.g., Deacon et al., 2007; Wang, Cheng, & Chen, 2006).

Most relevant for the present study, Wang et al. (2006) studied cross-linguistic relations of morphological awareness to word reading and reading comprehension by testing comparable Chinese and English morphological awareness tasks tapping both compounding and derivational morphology in Chinese-English bilingual children. They found that English morphological awareness of compound structure made a unique contribution to Chinese word reading and reading comprehension, beyond all other Chinese word-reading related variables. In contrast, the derivational morphological awareness task was not uniquely associated with Chinese word reading. The contrastive features across Chinese and English, particularly the fact that lexical compounding is very common in Chinese, make it an especially salient aspect of morphological awareness to measure in this language. We therefore sought to determine whether awareness of morphological compounding in Chinese might explain word reading in both Chinese and English in the present study of Chinese children of different grade levels.

Associations of Chinese-English biscriptal reading

A central issue of cross-language and cross-orthography studies is the extent to which common components are involved in the reading process of two languages. For example, recent studies on Chinese-English biliteracy acquisition have found that phonological awareness and orthographic experience in Chinese influence the process of learning to read English (Cheung, Chan, & Chong, 2007; Gottardo, Chiappe, Yan, Siegel, & Gu, 2006; Leong et al., 2005; Wang & Geva, 2003a; Wang et al., 2005).

One of the major findings from Chinese-English biliteracy acquisition is that Chinese phonological skills contribute to English word reading, similar to the findings on Spanish–English or French–English alphabetic language acquisition (Cisero & Royer, 1995; Comeau, Cormier, Grandmaison, & Lacroix, 1999). For example, one study by Wang et al. (2005) demonstrated cross-language phonological transfer in a group of Chinese immigrant children who learned English and Chinese. Their results suggested that a unique Chinese phonological skill, tone processing, is predictive of both Chinese word reading and English pseudoword reading. In contrast, in that study, orthographic skills focusing on tapping positional regularity and forms, were associated with Chinese word reading only, but not with English word reading. Similarly, a study on the relationship of phonological processing skills in L1 and L2 reading found that Chinese phonological processing skills were associated with both Chinese pseudoword reading and English word reading (Gottardo et al., 2001), underscoring the importance of phonological processing across languages.

Are there cross-linguistic effects of orthographic knowledge for reading Chinese and English? Wang and Geva (2003a) demonstrated that Chinese children learning English as an L2 outperformed native English-speaking children on confrontation pseudoword spelling, which demands visual-orthographic memory skills. In contrast, Wang et al. (2005) showed no crossover effect for orthographic processing skills. The different visual-orthographic skills required for Chinese and English word reading might explain why Chinese orthographic skills failed to explain

variance in English word reading in the latter study. The Chinese orthographic choice task used in that study focused on children's specific knowledge of positional regularity of radicals and the legality of the forms. These two types of orthographic knowledge may be specific to the Chinese orthography only; no corresponding counterparts were found for English word reading. Hence, no common visual-orthographic skills shared across both orthographies were tested in the task.

Some studies of Hong Kong Chinese children learning to read English as a second language have suggested possible transfer of Chinese orthographic processing to English word reading (Cheung et al., 2007; Leong et al., 2005). The results were explained in terms of the common process of analytical reading shared by both Chinese and English, as well as mutually reinforced structure sensitivity across the two languages. A recent study by Leong et al. (2005) assessed English word reading and spelling in Hong Kong Cantonese-speaking children learning English as an L2 and found that orthographic knowledge, focusing on discriminating real English words (e.g., *knife*) from pseudo English words (e.g., *nife*) and phonological sensitivity were highly correlated with English word reading. In addition, older Chinese children appeared to use more orthographic knowledge than phonological skills in reading and spelling of English words. A much stronger crossover effect of Chinese orthographic knowledge to English word reading was shown by Cheung et al. (2007) among Hong Kong fourth graders. In that study, an orthographic task designed to tap children's awareness of the function and positional regularity of Chinese radicals in a modification-structure word context was used, and the results showed that orthographic-phonological knowledge explained both English and Chinese word reading. Collectively, these results suggest that Chinese children might intuitively extract phonological and semantic information from orthographic forms to map onto spoken unit across scripts. However, the relative strength of specific orthographic knowledge in word reading and comprehension may vary across different writing systems (Cheung et al., 2007).

These associations across scripts suggest that Chinese phonological awareness and visual-orthographic skills might contribute to reading development in both English and Chinese in Hong Kong Chinese children (e.g., Cheung et al., 2007; Leong et al., 2005; Wang & Geva, 2003b). However, previous orthographic knowledge tasks were either English orthographic knowledge tasks (Leong et al., 2005) which might have involved phonological effects as well, or specific Chinese orthographic tasks tapping processes that are not required for English reading (Cheung et al., 2007; Wang et al., 2005). In the present study, therefore, we used a Chinese task that has an analogy to what is required for orthographic processing in English—distinguishing legal from illegal word components. Second, all of these listed studies excluded measures of morphological awareness, an important metalinguistic skill demonstrated in previous Chinese-English biliteracy acquisition (Wang et al., 2006).

To summarize, the present study incorporated commonly used measures of morphological awareness, phonological awareness, and visual-orthographic skill in relation to word reading in English and Chinese in two age groups. All three measures were administered in Chinese. Our focus was on how much each of these measures might contribute to reading in Chinese and English across two age groups.

Method

Participants

One hundred sixty-three second-grade students (73 girls, 90 boys; mean age = 96.96 months, SD = 4.87 months) and 163 fifth-grade students (78 girls, 85 boys; mean age = 132.65 months, SD = 5.46 months years) were recruited from five Cantonese-medium primary schools in Hong Kong, located in upper-middle-class neighborhoods across the New Territories, Kowloon, and Hong Kong Island. All of them were native Cantonese speakers.

All of these children were receiving a standard Hong Kong bilingual curriculum in which Cantonese and English were both emphasized. Indeed, learning English is sometimes regarded as more important than learning Chinese among the upper-middle-class of Hong Kong (Cheung et al., 2007). Hong Kong is unique among other Chinese cities for the age and manner in which children learn to read English. To begin with, Hong Kong Chinese children start to learn English around ages 4–5 years old, relatively early compared with other Chinese societies. In addition, no phonetic training on grapheme-phoneme correspondences is used to teach children learning to read English. Rather, children are usually taught to read English in using "look and say" method. In this method, the paired association between the pronunciations of the words and their spellings through rote memorization are emphasized. Cantonese is the primary spoken language in daily communication although both Chinese and English are official languages in Hong Kong. Spoken English is rarely used at home and in school settings except for English class, but written English tends to be a central focus in formal education. Moreover, there is relatively little chance for Hong Kong Chinese children to interact with native English speakers, and the schools pay more attention to comprehension and spelling of English words. Hence, Chinese children are encouraged to rely on visual patterns of written English words for mapping speech to print.

Measures

Chinese character recognition

A 61-item character recognition test and 150-item test adopted from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD) (Ho, Chan, Tsang, & Lee, 2000) were combined into a broad task for assessing second graders' and fifth graders' Chinese word reading ability. The first test was composed of 27 single Chinese characters and 34 two-character words, and the second test consisted of 150 two-character words. All of these items were arranged in increasing difficulty level. Across tests, children were required to read alone isolated words from the top to the bottom and the left to the right. Testing started from the beginning of the task, and testing was stopped either when the children failed fifteen items consecutively in the first test or in the second test. The maximum possible score of the combined task was 211.

English word reading

English word reading was measured with a reading list of 60 English words selected from Hong Kong Chinese children's English textbooks that are frequently used in kindergarten and primary school. All of these words were initially piloted with children of the same age, and they were ranked in order of increasing difficulty. Of these, the first 30 items have been successfully used previously to assess young Chinese children's reading ability in Hong Kong (e.g., McBride-Chang & Kail, 2002). The selection of the remaining 30 items was based on the pilot testing data of the children spanning from second to fifth grader. The children were required to read the words from the beginning to the end. Each correctly read word was given one point, and the maximum possible score was 60.

Raven's progressive matrices

Raven's Progressive Matrices were used to assess children's nonverbal intelligence (Raven, Court, & Raven, 1995). Twenty-four items ranked in order of increasing difficulty level were selected from Set A and Set B; each set consisted of 12 items. Each item consisted of a target geometric design with one portion missing and six option patterns. Children were required to choose the correct option from among six choices to complete the missing part of the geometric design. One point was allotted to every item correctly selected, and the maximum score was 24.

Phonological awareness

A phonological awareness task involving syllable deletion and syllable onset deletion was created following the design of the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999).

Syllable deletion, which was the first part of the test, consisted of 29 three-syllable words, both real and nonsense words, conforming to the constraints of Cantonese. Children were asked to delete the first, final, or middle (in order of difficulty, respectively) syllable (e.g., *lemon tea* without *tea* would be *lemon*), with 10 items for both the first and middle positions, and 9 items for the final position. When the children progressed beyond these items, a 22-item section of the test tapping syllable onset deletion was administered next. In this section, children were asked to delete the initial sound from a single syllable (e.g., *po4* without the initial phoneme would be *o4).* Eleven items each were presented across real words and nonsense words, respectively. Following extensive testing, we set the basal rule for this task such that if children failed in one item or less for a given block, they moved onto subsequent levels and were not tested backward at lower levels. The ceiling rule for this task was that testing stopped when children failed in six consecutive items for anywhere in the syllable deletion section and four consecutive items incorrect for the syllable onset deletion section. Testing started at the syllable onset level for second- and fifth-graders, but backward testing to the syllable level occurred when the basal was not reached for this block. The maximum possible score of this test was 51.

Morphological awareness

Morphological construction and homophone production were combined to form a measure of morphological awareness. Again, the style of this combination was intended to be similar to that of the Comprehensive Test of Phonological Processing (Wagner et al., 1999) in terms of basal and ceiling. Thus, the items were arranged in order of increasing difficulty with reference to pilot testing data which covered the children ranging from kindergartners to fifth graders. The same testing procedure described for phonological awareness test was used in this task.

The first section of this morphological awareness task consisted of 27 three-sentence scenarios. Each scenario described a specific object or concept and children were asked to actively form a compound word for a newly described object or concept by making use of lexical compounding. The two trial items were illustrated using pictures in order to make it as easy as possible for children to understand the concepts. This section tapped children's lexical compounding (e.g., a game in which a ball is thrown into a drawer could be called *drawerball*). The second and fifth-grade children started the testing at different items corresponding to what was found to be typical for their development levels in this section; if they got four or more items wrong consecutively, testing stopped. For those who performed well across most or all of these items, a second section involving the production of homophones from common words was then administered. Homophone production was used to tap children's abilities to generate homophones for given monosyllables. It consisted of fourteen items, and each item consisted of word construction and homophone production in two parts. For the first part, a target morpheme or monosyllable was provided in a word context and children were asked to form new words using the target morpheme within 10 s. For the second part, children were further required to generate words that included homophones of the target monosyllable within 10 s. Across both parts, one point was given if children could generate one or more words for each part. For example, a real testing item in Cantonese was that, given the target monosyllable /si6/ *示* in the word *表示 /biu2 si6/* (to express), children were required to come up with some new compound words such as *指示* (to indicate) /zi2 si6/, *暗示* /am3 si6/ (to imply), or *顯示* /hin2 si6/ (to show). Next, children were asked to give as many words including the homophone /si6/ *示* as possible, but the homophone was required to have different meanings and written forms but the same sound as /si6/ *示*, such as *電視* /din6 si6/ (television), *士兵* /si6 bing1/ (solider), *豉油* (sauce) /si6 jau6/, or *服侍* /fuk6 si6/ (to serve). This part of the test was a production exercise within a limited time, and it required a relatively high level of processing. All items were tested for this second part of the test only when children advanced to this level. The maximum possible score of this test was 55.

Visual configuration discrimination

This newly designed task was created to tap children's ability in using visual-orthographic knowledge to discriminate real nonlexical radicals and stroke patterns or components of Chinese characters from a set of misspellings and incorrect

nonlexical radicals or components of the Chinese characters. It consisted of 50 items, presented in increasing levels of difficulty. Of these, two types of items, nonlexical radicals and stroke patterns, either real or nonreal, were visually presented to the children. Nonlexical radicals were radicals that were not, themselves, independent characters with their own sounds and meanings, such as 扌. The component or stroke pattern was defined as the fixed visual-graphic constituent, conventionally recurring in a set of Chinese characters that could not be physically separated from the whole. These components were fundamental elements of characters without any specific cues for meaning categorization and pronunciation, such as 且, 广, 𠂢. The incorrect forms of nonlexical radicals or stroke patterns were created by adding, subtracting, and mirroring the real nonlexical radicals and components, such as 与, 𠂆, 灬. The children were asked to indicate whether each item was a real component of Chinese characters or not. The single item was listed on a single card and children were presented each item one by one. Each mark was scored when children correctly identified each real component or non-component. The maximum possible score for this task was 50.

Procedure

Consent was firstly obtained from parents and schools and a convenient testing time was arranged for all participating children. Participants were individually tested on all the measures in a quiet room of the school by the trained undergraduate psychology majors. All the testing used in this study was administered in a single session with 15 min of rest period in between. Thus, the testing lasted around 1.5 h and included the tasks described above, among others.

Results

Means, standard deviations, and reliabilities among individual measures used in this study are separately reported for second graders and fifth graders in Table 1. The internal consistency reliabilities for all the tasks in this battery were at or above .70. A significant overall grade effect was revealed in a multivariate analysis of variance (MANOVA) by entering all the six measures of language or cognitive skills, as well as reading outcomes simultaneously as the dependent variables, Wilks' $\lambda = .43$, $F(6, 319) = 71.16$, $p < .001$, partial $\eta^2 = .57$. The results of the follow up univariate analyses of variance of the grade difference in each individual measure are shown in Table 1. Not surprisingly, skills on all measures presented as raw scores improved across grade levels. Fifth-graders outperformed second-graders on all measures administered in this study.

Intercorrelations among phonological awareness, morphological awareness, visual-orthographic skills, nonverbal IQ, and reading outcome measures, partialling out children's age, are separately shown for second- and fifth-graders in Table 2. Clear within-language correlations among visual-orthographic skills, metalinguistic skills and Chinese word reading are indicated in Table 2. Both morphological awareness and visual-orthographic skills were moderately associated with Chinese

Table 1 Reliabilities, means and standard deviations and *F* tests for difference between second-grade and fifth-grade children for all measures

Measures	Reliability	Second-grade ($n = 163$)		Fifth-grade ($n = 163$)		F (1, 324)***
		M	SD	*M*	SD	
English word reading (60)	.97	26.34	12.90	40.23	10.65	112.49
Chinese character recognition (211)	.98	162.66	19.54	197.10	11.63	374.17
Raven's progressive matrices (24)	.73	19.50	2.86	21.34	2.28	41.27
Phonological awareness (51)	.96	36.18	8.77	44.30	7.59	79.83
Morphological awareness (55)	.95	33.33	11.98	46.98	4.12	189.01
Visual-orthographic skills (50)	.70	35.50	5.06	39.16	3.85	54.06

Numbers in parentheses represent the possible maximum score for each measure

*** $p < .001$

Table 2 Intercorrelations among various measures partialling out children's age

Variables	1	2	3	4	5	6
1. English word reading	–	.41***	.36***	.54***	.39***	.47***
2. Chinese character recognition	.56***	–	.23**	.21**	.35***	.36***
3. Raven's progressive matrices	.34***	.14†	–	.33***	.46***	.47***
4. Phonological awareness	.51***	.15†	.36***	–	.39***	.35***
5. Morphological awareness	.42***	.41***	.39***	.24**	–	.44***
6. Visual-orthographic skills	.41***	.29***	.31***	.24**	.38***	–

Correlations above the diagonal are for second-grade, and correlations below the diagonal are for fifth-grade

† $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

character recognition across grades, with correlations ranging from .29 to .41. In contrast, phonological awareness was significantly correlated with Chinese word reading for second-graders only, but not for fifth-graders. In addition, the cross-language correlations of phonological awareness, morphological awareness, and visual-orthographic skills and English word reading were modest, ranging from .39 to .54. All the other measures included in this study were significantly correlated with each other, either among the second-graders or the fifth-graders.

In order to further examine within-language and cross-language relations of visual-orthographic skills and metalinguistic skills to word reading, a set of multiple regression analyses was conducted. In each regression analysis, age (in months) and Raven's Progressive Matrices were included as the first step entry into the equation, controlling for nonverbal intelligence and age. To assess the independent roles of phonological awareness, morphological awareness, and visual-orthographic skills in reading Chinese and English, phonological awareness, morphological awareness, and visual-orthographic skills were entered as the second step. The analyses are summarized in Tables 3 and 4. The standardized regression coefficients (β), semipartial correlations (sr_i^2), R^2, and R^2 change, are reported in each table.

Table 3 Hierarchical regressions explaining Chinese word reading from age, nonverbal IQ, Chinese phonological awareness, morphological awareness, and visual-orthographic skills for second-grade and fifth-grade children

Variables	Second-grade					Fifth-grade				
	β	sr^2	t	R^2	ΔR^2	β	sr^2	t	R^2	ΔR^2
Step 1										
Age	.179	.030	2.434*	.101	.101***	.043	.002	.602	.020	.020
Raven's progressive matrices	−.010	.000	−.116			−.067	.003	−.816		
Step 2										
Phonological awareness	.034	.001	.419	.219	.118***	.046	.002	.583	.195	.175***
Morphological awareness	.234	.036	2.694**			.360	.100	4.409***		
Visual-orthographic skills	.240	.040	2.831**			.168	.022	2.108*		

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

Table 4 Hierarchical regression predicting English word reading from age, nonverbal IQ, Chinese phonological awareness, morphological awareness, and visual-orthographic skills for second-grade and fifth-grade children controlling for Chinese character recognition

Variables	Second-grade					Fifth-grade				
	β	sr^2	t	R^2	ΔR^2	β	sr^2	t	R^2	ΔR^2
Step 1										
Age	−.038	.001	−.601	.250	.250***	−.025	.001	−.461	.387	.387**
Raven's progressive matrices	.058	.002	.793			.080	.005	1.273		
Chinese character recognition	.234	.043	3.446**			.422	.144	6.944***		
Step 2										
Phonological awareness	.388	.115	5.649***	.442	.192***	.359	.109	6.043***	.538	.151***
Morphological awareness	.041	.001	.544			.080	.004	1.218		
Visual-orthographic skills	.211	.030	2.862**			.141	.016	2.305*		

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

Within-language associations of visual-orthographic skills and metalinguistic skills

The first question of this study was to identify the associations of phonological awareness, morphological awareness, and visual-orthographic skills with Chinese

character recognition. Hierarchical regression equations, explaining predictors of Chinese character recognition separately for second-graders and fifth-graders are reported separately in Table 3.

As shown in Table 3, morphological awareness was uniquely associated with Chinese character recognition in grades 2 and 5. The semipartial correlations between morphological awareness and Chinese character recognition were .04 ($p < .01$) and .10 ($p < .00$) for grade 2 and grade 5, respectively, after controlling for age, nonverbal IQ, and other reading-related measures. Moreover, visual-orthographic skills also appeared to be consistently predictive of Chinese character recognition for second-graders and fifth-graders separately, even with the effects of age, nonverbal IQ, and other reading-related measures removed. The semipartial correlations of visual orthographic skills with Chinese character recognition were .04 ($p < .01$) and .02 ($p < .05$) for second-graders and fifth-graders, respectively. However, phonological awareness did not play any independent role in Chinese character recognition. The within-language analysis of the relations of metalinguistic or cognitive skills with Chinese word reading indicated that morphological awareness and visual-orthographic skills were more strongly associated with Chinese word reading than was phonological awareness in both second- and fifth-grade advanced readers with age, nonverbal IQ and the other skills included together.

Cross-language associations of visual-orthographic skills and metalinguistic skills

The second focus was to examine whether Chinese visual-orthographic skills and metalinguistic skills could extend their associations to English word reading when other reading or language factors had been statistically controlled. This was addressed in a set of hierarchical multiple regression analyses explaining English word reading from Chinese phonological awareness, morphological awareness, and visual-orthographic skills with age, nonverbal IQ, and Chinese character recognition statistically controlled.

Analyses revealed that phonological awareness, measured in Chinese, was strongly associated with English word reading among both second-graders and fifth-graders even after accounting for the effects of age, nonverbal IQ, and Chinese character recognition (reported in Table 4). The semipartial correlations between Chinese phonological awareness and English word reading were .12 ($p < .001$), and .11 ($p < .001$) for second-graders and fifth-graders, respectively. Strikingly, the crossover effect of visual-orthographic skills from Chinese to English word reading was also strong, even with age, nonverbal IQ, Chinese character recognition, and other reading related measures statistically controlled. Chinese visual-orthographic skills were consistently associated with English word reading across second-grade and fifth-grade children and their semipartial correlations were .03 ($p < .01$), and .02 ($p < .05$), respectively. Such a clear cross-language association pattern of Chinese phonological awareness, and visual-orthographic skills with English word reading is consistent with previous findings demonstrating that Chinese phonological skills tend to predict

Chinese children's English reading (e.g., Chow, McBride-Chang, & Burgess, 2005) and also that orthographic knowledge transfers to English word reading among Hong Kong Chinese children (Cheung et al., 2007).

Discussion

This study was designed to examine the associations of visual-orthographic skills, phonological awareness, and morphological awareness to Chinese and English word reading skill in Hong Kong second- and fifth-graders who learned English as a second language. Three main findings of the within- and cross-language analyses are noteworthy. First, performance on phonological awareness, morphological awareness, and visual-orthographic skills improved with age. Second, both morphological awareness and visual-orthographic skills were uniquely associated with Chinese word reading across grades, even after controlling for age, nonverbal IQ and other reading-related skills. Interestingly, however, phonological awareness was not uniquely associated with Chinese reading in our samples. In contrast, we found an apparent cross-language transfer effect both from Chinese phonological awareness and Chinese visual-orthographic skills to English. However, there was no such cross-linguistic transfer from Chinese morphological awareness to English word reading once age, nonverbal IQ, and Chinese character recognition were statistically controlled. Thus, across English and Chinese, only visual-orthographic skills appeared to be consistently associated with word reading among either second-graders and or fifth-graders. These results add to the existing literature on Chinese-English biscriptal acquisition by showing that Chinese children whose L1 is Chinese, and who are learning to read English as a second language tend to adopt a visual-orthographic-based strategy. This appears to be the case for Hong Kong Cantonese-speaking children (Leong et al., 2005). These findings also lend some credence to the idea that Chinese-English biscriptal literacy acquisition is a process shaped by characteristics of given languages and relevant orthographic experiences (Leong et al., 2005; Wang & Geva, 2003b).

Findings of within-language contributions (i.e., Chinese morphological awareness and visual-orthographic skills are uniquely associated with Chinese word reading across both grades 2 and 5 as reported in this study) further support the idea of apparently robust effects of morphological awareness and visual-orthographic skills on learning to read Chinese, as consistently emphasized in previous research (Cheung et al., 2007; Ho et al., 2003; McBride-Chang et al., 2003; Shu et al., 2006). Children's ability to correctly discriminate slightly different graphic patterns is directly linked with Chinese character recognition (e.g., Huang & Hanley, 1995; Siok & Fletcher, 2001). In addition, a predominant role of lexical compounding in forming complex vocabulary, and the large number of homophones existing in Chinese both make morphological awareness uniquely important in learning to read Chinese characters (McBride-Chang et al., 2003; Shu et al., 2006). In contrast, phonological awareness was less salient in explaining Chinese word reading across grade 2 and 5 with other variables statistically controlled. These findings suggest that visual-orthographic skills and morphological awareness, but not phonological

awareness, tend to be among the more crucial components involved in Chinese word reading for both intermediate and advanced readers.

One striking finding of this study was the strong crossover effect of Chinese visual-orthographic skills on English word reading. This further supports recent findings with Hong Kong Cantonese-speaking children by Cheung et al. (2007), as well as with findings on Chinese children learning to read and spell English words (Leong et al., 2005). There are at least three plausible reasons why Chinese visual-orthographic skills were cross-linguistically associated with English word reading. First, across languages, the essence of learning to read is the ability to derive meaning or sound from print (Cheung et al., 2007). The Chinese character is a unit that combines sound, form, and meaning, and it has a unique visual-spatial configuration that is generally composed of different structural components, i.e., strokes, stroke patterns, or radicals. Moreover, each of these structural components has a strong combinability, and it can occur in different characters representing different sound and meaning in a variety of combinations. Consequently, some Chinese characters might have a slightly different configuration but with sharply contrasting sounds or meanings. For example, 書 /syu1/(book) and 畫 /waa6/ (drawing) both have quite similar stroke patterns, but their sounds and meanings are completely different. Hence, visual-orthographic skills are helpful to discriminate the target character from slightly different alternatives to map onto sounds. The ability to read accurately Chinese characters shares some similarity with what is needed to process strings of letters with similar combinations but with different meanings and sounds, such as *sign* and *sing*, *are* and *ear*, *leak* and *lake*, *blow* and *bowl.* In support of this idea, Wang and Geva (2003b) have demonstrated that, relative to native English learners, Chinese children learning to read English as a second language make particular use of orthographic skills in learning to read English as well.

A second plausible reason for the importance of visual-orthographic skills across orthographies in Chinese children is that analytical skills, referring to decomposing the word into legal units in order to give clues to sound or semantic category of the whole word, tend to be important for correctly identifying and reading both Chinese characters and English words. For example, 清 /cing1/ (clear) would be decomposed into a non-lexical semantic radical 氵 and the phonetic radical 青 /cing1/ (green). Similarly, *sea* would be divided into *s* /s/and *ea* /i:/. Given the correspondence of graphemes to phonemes in English, children's sensitivity to separate units or parts of Chinese characters in this visual-orthographic task likely facilitated children's English word reading by reinforcing or transferring analytical skills.

The third plausible reason for the strength of association between the visual-orthographic task and English reading may be that educational practice and L1 orthographic learning experience might interactively influence the process of L2 learning. As noted by Leong et al. (2005), learning to read two different languages might reinforce children's sensitivity to the structures of these languages. However, how two languages interactively influence one another is contingent upon the commonality of these two languages, as well as the educational practices or teaching methods of the environment in which reading takes place. Hong Kong is a unique place in which to investigate Chinese children learning to read English as a

second language due to its educational practices that are similar for both Chinese and English. In Hong Kong, children are likely to be taught to read Chinese characters using the "look and say" method and children are encouraged to focus more on holistic visual patterns of characters, rather than analyzing them. Similarly, there is no phonics training for Hong Kong children learning to read English in most schools. Rather, teachers tend to adopt the "look and say'' method to make children more attentive to visual forms rather than alphabetic codes using rote memorization. It is possible that reliance on visual-orthographic skills in word reading may diminish with reading experience, however. Future work should test for the generalizability of this pattern across age. Our results also make us particularly curious about the possibility that educational interventions or learning and teaching methods for both Chinese and English might influence children's reading strategies for English word reading and render children relatively sensitive to visual-orthographic patterns of English words.

In relation to English reading, there was strong evidence that nonalphabetic phonological processing skills might be helpful for decoding alphabetic languages. Our results showed that Chinese phonological awareness was strongly associated with English word reading even after the effects of Chinese word reading and other reading-related measures were removed. This further supports the idea that phonological transfer might not be limited to languages with similar phonological structures (Chow et al., 2005; Gottardo et al., 2001; Saiegh-Haddad & Geva, 2007). The Chinese task of phonological awareness designed for this study taps children's ability to segment or manipulate syllables and syllable onsets, which are also important for reading in English. As has been suggested elsewhere, phonological processing is a universal aspect of reading acquisition (Hu & Catts, 1998; Saiegh-Haddad & Geva, 2008), and phonological awareness is a cognitive-linguistic construct that underlies word reading across scripts (Saiegh-Haddad & Geva, 2007; Perfetti, Liu, & Tan, 2005). In addition, the cross-linguistic association of Chinese phonological skills with Chinese children's English word reading may imply that word reading is a universal process of deriving the sound from the print across languages (Cheung et al., 2007), but it is perhaps constrained by the commonalities shared across languages.

Although the pattern of results demonstrated here contributes to understanding Chinese-English biscriptal acquisition, this study examined correlations of data at a single testing-time only. The correlational nature of the current study, cannot answer questions related to the causal relations of visual-orthographic skills and metalinguistic skills to Chinese and English word reading. Future studies might examine these processes using a longitudinal design to focus more on development across cognitive skills. Moreover, our central measures focused on metalinguistic or cognitive processing only, without inclusion of verbal working memory, speeded naming, vocabulary knowledge, and other oral linguistic skills that have been demonstrated to be correlated with word reading among elementary school readers (Nagy et al., 2003, 2006; Shu et al., 2006), possibly limiting our ability to explain maximum variability in Chinese word reading.

In addition, in the present study, Chinese children's spoken or written language ability outstripped their competence in English, and the English word reading

instruction they received was centered on spelling patterns and their meanings rather than alphabetic codes. The unequal competences across Chinese and English might influence transfer effects of native Chinese skills to English word reading. At the same time, however, these children were relatively competent intermediate and advanced readers, at least at the word level. Future research on cross-language transfer or biscriptal acquisition might consider examining similar patterns in balanced bilinguals who speak both Chinese and English. Such a study might provide further evidence on whether learning two different orthographies could interactively facilitate one another (Byrne, 1996; Leong et al., 2005).

Despite these remaining questions, the results reported in this study highlight commonality and uniqueness in biscriptal acquisition and offer evidence for the significance of visual-orthographic skills in understanding Chinese-English bilingual educational practice. The results revealed that visual-orthographic skills are common components or skills involved in learning Chinese and English, two contrasting orthographies, and they emphasize the fact that skills in a native language might facilitate children's sensitivity to the orthographic and phonological structures in the other language. Thus, a possibly effective educational intervention would center on enhancing children's performance on the common skills involved in reading in two orthographies. On the other hand, the crossover effect of visual-orthographic skills from Chinese to English word reading might further imply that Chinese children perhaps treat English words similarly to the way they treat Chinese characters, i.e., as meaning units, rather than alphabetic codes. This might be true particularly given that the Chinese children in the present study were taught both English and Chinese through the "look and say" method, which emphasizes more visual-orthographic patterns and meanings (Leong et al., 2005). At the same time, phonics and the alphabetic principle are seldom systematically taught in Hong Kong. This might explain why Hong Kong Chinese children have well-developed comprehension skills but can be somewhat weak in pronouncing printed English words. Hence, the findings of the present study might suggest that a better way to learn English as a second language might be to include elements of print used by phonics advocates, e.g., more focus on letter knowledge, spelling patterns, and phonetic coding. Additionally, strong evidence that Chinese phonological skills transfer to English wording has again been reported, supporting findings from previous research (e.g., Gottardo et al., 2001). At the same time, Chinese morphological awareness did not transfer, supporting the idea that certain skills are language-specific (Cheung et al., 2007). These findings underscore the idea that phonological processing skills might be universals and, thus, the training of phonetic processing in one language can essentially contribute to the other language. However, morphological awareness might be somewhat more specialized within a language, depending on the nature of the morphological awareness task considered. Overall, it might be particularly effective to improve children's biliteracy performance by combining these established commonalities and specificities in educational practice.

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