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Understanding the Mapping Principle of One Syllable One Character as a Predictor of Word Reading Development in Chinese

Dan Lin[1*] Ling-Po Shiu[2] Yingyi Liu[1]

[1] The Education University of Hong Kong
[2] The Chinese University of Hong Kong

Speech–print mapping awareness is defined as the awareness of the principles underpinning how speech sound is matched to print symbols. Chinese is unique in that it follows the one syllable one character mapping principle. The present study examined the predictive power of speech–print mapping awareness in young children's word reading. Seventy-four Hong Kong children from the first and second kindergarten years were tested with phonological awareness, visual skills, syllable-level mapping awareness, and Chinese reading ability at Time 1. Chinese reading abilities were tested again 1 year later. It was found that syllable-level mapping awareness predicted Chinese word reading abilities 12 months later. Further, it seemed that the link of syllable mapping to Chinese reading is particularly significant for beginning readers. The findings suggest that understanding the language-specific speech–print mapping principle is critical for reading acquisition at the early stage of reading development.

Keywords: speech–print mapping awareness, phonological awareness, visual skills, Chinese reading

There is strong evidence that phonological awareness (Ho & Bryant, 1997b; Shu, Peng, & McBride-Chang, 2008) and visual skills (Huang & Hanley, 1995; Siok & Fletcher, 2001) play important roles in Chinese reading development. A further step in learning reading is to establish the mapping between speech and print symbols. This is of much concern because the mapping of speech to visual symbols across visual and auditory domains reflects an essential mechanism underlying learning to read (Ehri, 1998; Shu & Anderson, 1999). Many researchers have claimed the importance of the mapping process in Chinese reading development (McBride-Chang & Chen, 2003), yet empirical evidence is lacking. The present study investigated the role of understanding the mapping principle of speech–print (i.e., one syllable mapping to one character in Chinese) in predicting Chinese reading development longitudinally beyond phonological awareness and visual skills among children in lower kindergarten grades.

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Theoretical Framework of Reading Acquisition in Chinese

As Ziegler and Goswami (2005) stated, "the first steps in becoming literate…require acquisition of the system for mapping between symbol and sound" (p. 3). In Figure 1, we illustrate the theoretical framework showing how various cognitive skills work together for Chinese reading acquisition in young children. The constituents of phonological awareness, visual skills, speech–print mapping awareness, and their relationships to Chinese word reading are described below, with a focus on speech-print mapping awareness.

Phonological awareness is a listening skill that segments speech into smaller units, such as syllables (onset, rime, and tone in Chinese) and phonemes, and manipulates these units (Høien, Lundberg, Stanovich, & Bjaalid, 1995; Treiman & Zukowski, 1991). Children's development of phonological awareness progresses from larger (i.e., syllable) to smaller (i.e., phoneme) units, as postulated in the grain size theory (Ziegler & Goswami, 2005). In Chinese, syllable awareness has been consistently reported to be important for kindergarten children in Chinese word reading (McBride-Chang, Bialystok, Chong, & Li, 2004; Shu et al., 2008), whereas phoneme or tone awareness has been found to be associated with Chinese word reading in older primary school children (Huang & Hanley, 1997; Siok & Fletcher, 2001). However, children of kindergarten age have demonstrated a floor effect on phoneme awareness (Lin et al., 2010) or performed at the chance level (Shu et al., 2008). Thus, in the present study, syllable awareness was tested on lower grade kindergartners.

Visual and orthographic knowledge are sometimes considered together because they both involve print, which is perceived visually. The difference between them is that visual skills refer to those abilities that make use of visual information not related to linguistics, whereas orthographic awareness focuses on children's knowledge of specific print patterns (Li, Shu, McBride-Chang, Liu, & Peng, 2012; Lin, Sun, & Zhang, 2016; McBride-Chang, Chow, Zhong, Burgess, & Hayward, 2005). Positive associations have been found between

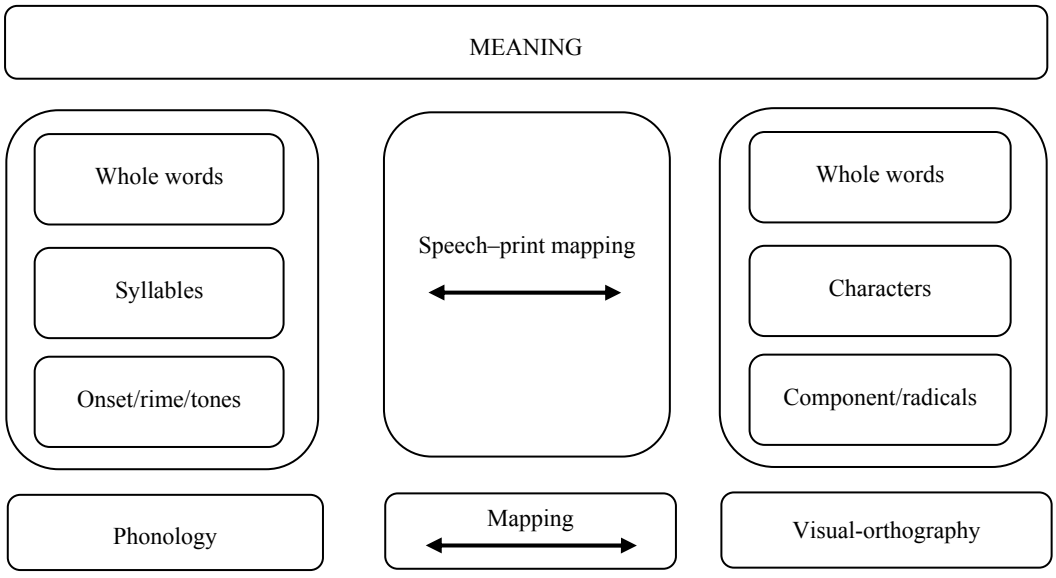

Figure 1. Schematic depiction of Chinese reading acquisition. Adapted from Ziegler and Goswami (2005).

visual skills and Chinese word reading, particularly in children in the lower grades (McBride-Chang et al., 2005, 2011; Tong et al., 2011), probably because Chinese characters contain much visual information (Wang, Inhoff, & Chen,1999). The role of orthographic knowledge in learning to read Chinese is stronger in older primary school children, when they have relatively more literacy experience and start to attend the internal structures of Chinese characters (Shu, Anderson, & Wu, 2000; Siok & Fletcher, 2001). In the present study, we tested children's visual skills, as this is more age appropriate.

The Concept of Speech–Print Mapping Awareness

Speech–print mapping awareness is defined as the ability to match speech to print symbols. It should be distinguishable from syllable awareness, which has been investigated widely in previous studies. Syllable awareness requires the ability to access and manipulate sound at the syllable level, which is a listening skill operating in the auditory modality (Li et al., 2012). However, the ability to isolate syllables does not necessarily ensure a successful mapping of a syllable onto its written code. Mapping skills require establishing an association between syllables and their corresponding written words, which involves an integration of information from both auditory and visual modalities. Therefore, in contrast to the traditional syllable awareness, speech–print mapping awareness uniquely emphasizes the understanding of the mapping principles on how a speech unit corresponds to its print unit (i.e., syllable to character in Chinese).

Speech–print mapping principles vary widely across writing systems: alphabetic systems map a grapheme to a phoneme, while logographic systems map a grapheme to a syllable (Perfetti & Dunlop, 2008). Different from English, where phoneme level is more helpful in reading (Hulme et al., 2002), there is no phoneme-level correspondence to grapheme in Chinese. There is an important principle in learning Chinese characters; that is, one syllable corresponds to one character. If this principle is not respected in word reading, mistakes in word learning are unavoidable. For example, the syllable *hou2* corresponds to the character 好. If the two syllables *hou2 yan4* (好人, *good man*) are assigned to one character 好, children will have great difficulty in learning words. In this example, 好 has two components, 女 and 子, which are two real characters when they are presented separately. Thus, if a child assigns two syllables *hou2yan4* to the character 好, s/he may mistakenly assume that the two components, 女 and 子, should be pronounced as *hou2* and *yan4*, which are actually *neoi5* and *zi2*, respectively. As illustrated in this example, it is very important to understand and observe the one syllable one character principle in Chinese. Therefore, the present study investigated whether the understanding of the speech–print mapping principle could predict unique variance of Chinese reading development beyond traditional syllable awareness and visual skills.

Although there might be other languages following the one syllable one character mapping principle (e.g., Korea), this is still a very special mapping principle, different from most alphabetic systems and some other logographic systems as well. In English letter–sound connections, there could be multiple graphemes corresponding to one syllable, such as *tree* or *though*. There could also be multiple syllables corresponding to one word, such as *excellent*. To establish these grapheme–phoneme correspondences of the writing system, readers need to be able to read unfamiliar words on their own by applying decoding, analogy, or prediction strategies, thus to activate orthographic mappings (Ehri, 2014). In logographic systems, how character maps to syllable varies as well. For example, the Japanese Kanji, which is very similar to the Chinese characters, can have character corresponding to one, two, or multiple syllables. For instance, the two-character word 橫濱 (a city in Japan) is pronounced as *yo-ko-ha-ma*

(four syllables), and the one-character word 私 (meaning *I*) is pronounced as *wa-ta-shi* (three syllables). These are multisyllable words, with their spelling represented by different numbers of characters. Clearly the one syllable one character mapping principle does not apply to Japanese Kanji. By contrast, Chinese as a monosyllabic language; character is the basic graphic unit, and one syllable consistently corresponds to one character (e.g., 我 corresponds to *ngo5* [meaning *I*]; Shu, Chen, Anderson, Wu, & Xuan, 2003).

Association of Speech–Print Mapping Awareness to Reading

The important role of speech–print mapping awareness has been noted by researchers for a long time, mostly in English reading (Share, 1995). Although no explicit syllable- or phoneme-level mapping onto words is available in English, English reading conforms to the pattern that one spoken word corresponds to one written word. Clay (1991) conducted a longitudinal study of 5-year-old New Zealand children and concluded that children must be able to match spoken words to written words if they are to become independent readers. Evans, Taylor, and Blum (1979) tested first graders in a longitudinal study with a battery of linguistic awareness tasks and found that reading achievement was especially highly correlated with the skills to match speech stream with printed symbols, rather than with tasks that focused more on orthography.

Later studies replicated and extended these early findings. Finger-pointing reading was found to predict reading achievement. Morris (1993) conducted a longitudinal study of 53 kindergarteners four times over a school year to investigate the causal relationship between phonological awareness, finger-pointing reading, and reading development. Finger-pointing reading was operationalized as mapping spoken words to written words in reading a short, memorized text. The study provided evidence for a developmental model showing that the children first became aware of initial consonants and that finger-pointing reading ability bridges the initial consonant awareness and phoneme awareness, which further facilitates the development of word reading. The important role of finger-pointing reading in reading development and the developmental sequence were supported further and replicated using different research approaches (Flanigan, 2007; Morris, Bloodgood, Lomax, & Perney, 2003).

We hypothesized that children's understanding of one syllable mapping to one character is important to Chinese reading development for two reasons. First, speech–print mapping approximates a fundamental process of reading. To be able to read, children must learn the code for representing speech as visual symbols (Liberman & Shankweiler, 1979). Although much research has used various measures to uncover this process, most of them operate in a single modality such as syllable detection (Shu et al., 2008) and morphological production (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003) or involve complex mechanisms such as rapid automatized naming (Torgesen, Wagner, Rashottle, Burgess, & Hecht, 1997) and invented spelling (Tangel & Blachman, 1992). Measures precisely reflecting the speech–print connection across visual and auditory modalities in Chinese are lacking.

Second, the ability to connect speech to characters may be extremely important in Chinese because of the morphosyllabic and opaque nature of Chinese characters (DeFrancis, 1984). In some transparent orthographies, such as Spanish, children may use letter or phoneme information to decode the orthography (Ziegler & Goswami, 2005) even if they do not have a strong sense of specific spoken and written word correspondence (Ehri & Sweet, 1991; Morris et al., 2003; Uhry, 2002). However, this is not possible in Chinese because the phonetic information in Chinese characters is unreliable and Chinese is typically characterized as a sound-opaque language: a fundamental first step is to establish the syllable–character correspondence. Kuo and Anderson (2006) mentioned a similar idea in a review paper that

graphophonological awareness, the knowledge about the grapheme–phoneme and phoneme–grapheme conversion rules of a language, promotes decoding skills. However, empirical evidence is not solid regarding the ability to map speech to print or its predictive power in Chinese word reading.

Considering Speech–Print Mapping Awareness in the Developmental Context

We expected that the link between speech–print mapping awareness and Chinese word reading would be stronger in children with lower levels of reading proficiency than in those with higher levels. This was motivated by the hypothesis of shared limited capacity. In this hypothesis, higher-order skills become available when some basic component processes are developed and thus reduce the cognitive demands (McBride-Chang & Chen, 2003; Perfetti & Hogaboam, 1975). We hypothesized that understanding the mapping principle of speech to print would be particularly important in an early stage of reading development because this is the first step for children to locate the corresponding written counterparts of the spoken words (Morris et al., 2003). Equipped with this mapping ability, children might come to attend more to the internal structure of the word and character (Ho & Bryant, 1997a). By then, other cognitive skills, such as orthographic awareness, might become essential (Li et al., 2012). Thus, in the current study, we particularly targeted children with low reading proficiency (i.e., in the first and second years of kindergarten).

The Present Study

We used a task of syllable mapping to measure speech–print mapping awareness in which children were asked to point out the written correspondence of a particular syllable spoken by an examiner in a three-character printed word. This measure was adapted from previous tasks but was made relevant to the characteristics of Chinese and the developmental stage of the children in our study (Clay, 1991; Morris, 1981, 1993).

Morris (1993) found that, when asked to match an orally recited sentence to the sentence in print, children used spaces between words and the beginning letters of each word as hints. Because of the lack of consonants (or any phonic cues) and spaces between words in Chinese, the story or poem tasks could have been too difficult for our 4-year-old participants. Although, in English, sentences or poems are appropriate contexts for testing children's understanding of the concept of a word, in Chinese, words, usually consisting of two or four characters, provide a more appropriate context for testing children's understanding of mapping syllables to characters, as the sentence or poem context could be too complicated for lower-grade kindergarteners. Additionally, the word context is in line with the real-world instructional practice, which is *look and say* the words to be learned. It requires children to match completely unknown words in oral and written forms.

With speech–print mapping awareness measured at the syllable level, the aim of the present study was to examine the extent to which speech–print mapping awareness accounts for unique variances in Chinese word reading longitudinally beyond phonological awareness and visual skills in Hong Kong kindergarteners.

Method

Participants

The participants were 61 Hong Kong Chinese children (29 girls), of whom 29 were in their first kindergarten year and 32 in their second. All of these children were also native Cantonese speakers recruited from a government-supervised local kindergarten located in a lower-middle SES area in the New Territories of Hong Kong. They started formal reading and writing of Chinese characters in the second semester of the first year, when the

children were about 3.5 years old, with Cantonese as the main medium of instruction. None of the children had obvious vision, hearing, or language-delay problems, as reported by their teachers.

Measures

Syllable-mapping awareness. Syllable mapping assesses whether or not children can match an orally presented syllable to a written character by pointing it in the correct position. The experimenter orally presented the children three-syllable or four-syllable words. Meanwhile, the children were presented with the written form of the words printed on a card (21 cm x 14 cm). For example, in 電視機 (*television*), the experimenter first pronounced */din6/ /si6/ /gei1/* and presented the children the three characters, then asked the children to find the character corresponding to */si6/*. This task was similar to the finger-pointing reading task, in which children were asked to point out a selected word on a line of text in response to an utterance by the experimenter (Gillet, Temple, & Crawford, 2004).

There were 57 items: 48 three-character and 9 four-character noun words. The words were selected with the intention to include a maximal variety of noun words and to have the initial, middle, and final positions examined while acknowledging the fact that Chinese words are most commonly composed of two or three characters. The target words were chosen carefully to be orally familiar to children at that age, but their written forms were not known to the children as much as possible (Tse, 2006).

A backward-checking step was carried out at the end of the testing period to ensure that the children indeed relied on word length but not word recognition. They were asked to identify the characters in each word used in the syllable-mapping task. Any character recognized by the child was excluded from the scoring to eliminate the possibility that the child used character recognition to make the correct response. Thus, the number of valid mapping items was computed by the total items minus the number of words in which the child could recognize one or more characters. Given that children could vary in the number of total valid mapping items, the final proportion score was calculated for each child with this formula: the number of correct mapping items among the number of total valid mapping items divided by the number of total valid mapping items. The maximum possible score was 1. Only participants with five or more total valid mapping items were included in our analyses for reliability concerns. Given that the number of excluded items for each participant was not the same, it was not possible to compute the Cronbach's alpha reliability based on the remaining items. As an estimation of the reliability of this measure, we computed the Cronbach's alpha based on all 57 items, and the score was .96.

Phonological awareness. Phonological awareness was measured by the syllable isolation task. The children were asked to isolate the initial, middle, or final syllable in an orally presented three-syllable phrase. For example, the child was asked to say aloud the initial syllable of */daai6/ / mun4/ /hau2/*, and the correct answer should be */daai6/*. There was a total of 16 items. Five required isolating the first and final syllable, respectively, and six required isolating the middle syllable. One point was awarded for each correct answer. A similar task has been used successfully in previous studies (Lin, et al., 2010).

Visual spatial relationships skills. The visual spatial relationships task (Gardner, 1996) measures children's spatial-orientation skills. The children were asked to select a target figure that was presented partly or holistically in a different orientation from four other simultaneously presented figures. There were a total of 16 items, with one point being awarded for each correct response. This task has been well used with Hong Kong kindergarteners (McBride-Chang et al., 2011).

Chinese word reading ability. The children were required to read 27 one-character and 33 two-character words arranged in increasing difficulty. The testing stopped when a child failed to read 10 consecutive items. One point was credited for each correctly read item; the maximum possible score was 60. This task was adopted from a reading task that has been used successfully with Hong Kong Chinese kindergartners (Ho & Bryant, 1997b; McBride-Chang & Ho, 2000).

Procedure

All measures were administered in the children's native tongue (i.e., Cantonese) individually in a quiet room in the kindergarten by trained student examiners (all psychology or education majors). The order of these measures was counterbalanced across participants. The whole process lasted around 30 min. All measures were administered at Time 1 (T1) in May. The Chinese word reading task was administered again 12 months later at Time 2 (T2).

Before the main testing, a screening criterion was applied to all participants. Only children who could count from 1 to 10 and who could count the number of characters in five one- to four-character printed words were included in the study. The purpose of the counting and character numbering criteria applied to screen qualified participants was to minimize the co-confounding of counting in the children's performances on the mapping task. Three children did not pass the counting criterion; two pointed to the same position for over 95% of the items; and eight participants were able to recognize more than 52 items in the syllable mapping measure (total valid mapping items < 5). These 13 children were excluded. As a result, 61 children were included in the statistical analyses.

Results

The means, standard deviations, skewness, kurtosis, and correlations of all variables are shown in Table 1. The correlation coefficients for all variables of age, visual skills, phonological awareness, syllable mapping, and Chinese word reading ranged from .305 to .742, and all were significant. Notably, syllable mapping (M = .58, SD = .26) was significantly correlated with Chinese word reading at T1, r = .666, p < .001, and T2, r = .655, p < .001. The strong correlation of syllable mapping to phonological awareness, r = .742, p < .001, suggested some significant overlap of these two constituents. To check potential bias for children in position pointing, we calculated the accuracies of syllable mapping for the three different positions (for the four-character words, pointing to either the second or third character was counted as the middle position). The score ranged from .64 to .67, and no significant differences were found among the three positions, F = .56, p = .57.

Hierarchical regression analyses were conducted with Mplus (Muthén & Muthén, 1998–2010). Of particular interest, to

Table 1
Means, Standard Deviations, Skewness, Kurtosis, and Correlations Among Variables

Variables	*Mean*	*SD*	Skewness	Kurtosis	Reliability	1	2	3	4	5	6
1. Age (Month)	55.34	6.19	−.279	−1.042	—	—					
2. Visual skills (16)	6.92	3.86	.075	−1.126	.82	.491***	—				
3. Phonological awareness (16)	8.43	5.40	−.165	−1.402	.94	.305*	.425**	—			
4. Syllable mapping (1)	0.58	0.26	.322	−1.552	.96	.391**	.466***	.742***	—		
5. Chinese word reading (T1; 60)	17.15	11.69	.553	−0.104	.96	.524***	.367**	.539***	.666***	—	
6. Chinese word reading (T2; 60)	38.07	13.92	−.273	−0.921	.97	.509***	.447***	.562***	.655***	.732***	—

Note. N = 61.
*p < .05. **p < .01. ***p < .001.

investigate potential different effects of syllable mapping to word reading ability for children with different levels of reading proficiency, an interaction term of Mapping × Reading (T1) was created as a predictor of T2 reading in the hierarchical regression analysis. As shown in Table 2, with age, grade, gender, visual skills, phonological awareness, and T1 reading statistically controlled, syllable mapping predicted reading at T2, $p = .052$, at a level of marginal significance. Notably, the interaction term Mapping × Reading was significant, $p = .013$. This suggested that syllable mapping was particularly important to reading development for poor readers, while the prediction of syllable mapping to reading was less obvious for students with higher levels of reading proficiency. In total, 65.3% variance in reading at T2 was explained by the model, $p < .001$.

To better illustrate the Mapping × Reading (T1) interaction effect, we split our data further into two categories (poor readers vs. good readers) according to whether a child's reading score at T1 was beyond the mean score of reading at T1. Thirty-two and 28 children were classified as poor readers and good readers, respectively. The regression analysis results are shown in Table 3. As expected, the effect of syllable mapping was significant for the poor readers, $p = .047$, but not for the good readers, $p = .634$.

Table 2
Hierarchical Regression Model Predicting Chinese Word Reading (T2)

Predictors	*B*	*SE*	*β*
Age	0.033	0.368	.015
Grade	0.488	5.089	.018
Gender	3.751	2.207	.135
Visual skills	0.334	0.344	.092
Phonological awareness	0.058	0.326	.022
Reading (T1)	0.649	0.134	.545***
Syllable mapping	14.924	7.690	.280†
Mapping × Reading (T1)	−0.900	0.361	−.181*

Note. $N = 61$.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$

Table 3
Hierarchical Regression Analyses in Poor Readers and Good Readers

Predictors	Poor readers ($n = 33$)			Good readers ($n = 28$)		
	B	*SE*	*β*	*B*	*SE*	*β*
Age	−0.028	0.666	−.013	1.089	0.361	.717**
Grade	2.348	7.814	.091	−7.818	4.291	−.404
Gender	5.347	3.781	.224	−4.347	3.129	−.257
Visual skills	−0.020	0.646	−.006	0.708	0.419	.267
Phonological awareness	−0.181	0.477	−.077	0.494	0.447	.251
Reading (T1)	0.799	0.476	.368	0.556	0.125	.548***
Syllable mapping	26.169	13.196	.412*	−4.406	9.259	−.115

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

Discussion

The results show that speech–print mapping awareness longitudinally predicted T2 Chinese reading even with the autoregressive effects of T1 Chinese reading, phonological awareness, and visual skills statistically controlled in kindergarteners with lower levels of reading proficiency. Despite the significant correlation between syllable mapping and phonological awareness, the regression analyses suggested that there was something special in syllable mapping beyond phonological awareness and that this special component (i.e., understanding of one syllable one character mapping principle) was uniquely important in Chinese word reading development. The findings of the present study are considered to parallel previous studies in English reading emphasizing the importance of grapheme–phoneme knowledge (Ehri, 1998)

It is not surprising that the syllable mapping task was significantly correlated with phonological awareness, a well-established predictor of reading development (McBride-Chang et al., 2004; Shu, Peng, & McBride-Chang, 2008), because the mapping task and phonological awareness task both require skills in manipulating speech to some extent. However, they are conceptualized and operationalized differently and point to different reading mechanisms. Notably, syllable mapping accounted for the unique variance in reading development beyond phonological awareness, even with visual skills and the autoregressive effects of T1 reading controlled. Beyond accessing and manipulating speech in the auditory modality (Anthony & Francis, 2005; Høien et al., 1995; Torgesen et al., 1997), speech–print mapping requires matching speech to its corresponding print symbols.

As one of the constituents in word reading, speech–print mapping distinguished itself from reading in conceptualization. Children being able to match a particular speech unit to a particular print unit were not necessarily able to read out that particular print. For example, a child may have been able to link the spoken sound *[bə□t]* to the print word *boat* or *['eksələnt]* to *excellent* but not necessarily able to pronounce *[bə□t]* or *['eksələnt]* when seeing the word of *boat* or *excellent.* The syllable in Chinese is a salient unit for learning to read (Ziegler & Goswami, 2005). This clear and simple one-to-one mapping principle, which contrasts sharply with other linguistic systems, makes it particularly prominent in learning to read Chinese and easy enough for beginners to learn in practice.

In a closer examination, children's reading proficiency was considered because it is more direct and sensitive to reflect children's *reading development age*. The significant interaction effect of syllable Mapping × Reading (T1) suggests that understanding the Chinese mapping principle of one syllable one character is particularly influential to Chinese word reading in children with lower reading proficiency or beginning readers compared to those with higher proficiency. At an early stage of reading development, it is important to establish the one syllable one character connection. Perhaps only after that, children are able to attend more consciously to the structure of phonology, orthography, or meaning within syllables or characters (Morris, 1992, 1993), and, thus, other cognitive skills such as morphological awareness and orthographic awareness become essential (Li et al., 2012; Liu, McBride-Chang, Wong, Shu, & Wong, 2013; Shu, McBride-Chang, Wu, & Liu, 2006). The whole picture of the relative importance of each constituent to reading as a function of reading development can be addressed better in future longitudinal studies with all related cognitive skills measured systematically.

The finding that the syllable-level speech–print mapping awareness uniquely predicted Chinese reading development are consistent with previous results for English reading, which showed that being able to locate a word accurately was helpful to learning that word eventually (Morris et al., 2003). However, given the fact that different mapping rules are used in different languages, there could be

subtle differences in how mapping rules work across different languages. For example, while syllable-level mapping was found to be important for Chinese reading in the present study, it is not entirely clear how speech–print mapping at the phoneme, syllable, or word level is related to English reading development or how they can be different or similar to Chinese reading, despite ample research demonstrating the importance of phoneme awareness to English reading development (Hulme et al., 2002). In the future, cross-language studies would be particularly interesting and helpful to address these questions.

There were some limitations in the present study. Because the present study was the first of its kind to develop the measure of speech–print mapping awareness, the measure could be refined further. For example, phonetic and semantic radical information could be taken into consideration in developing the materials. A second limitation of the present studies was that we only included phonological awareness and visual skills as cognitive controls. In future studies, variables such as morphological awareness and orthographic awareness should be considered (McBride-Chang et al., 2003). In addition, future studies with longer developmental periods would be particularly interesting to investigate how each of the cognitive skills is associated developmentally with reading development across age. A third limitation of the present study was that our data were correlational only, and no causal relationship can be determined from the findings. In the future, intervention or training studies would be helpful to determine any causal relationships.

Despite these limitations, the present study contributes to the literature by revealing the importance of understanding the mapping principle of the language system and its unique contribution to reading development in beginning readers. From a theoretical standpoint, the present research delineates an important cross-modality linguistic constituent of speech–print mapping awareness in early reading development. Reading is not only about understanding visual or oral symbols but is a precise integration of language-specific visual and oral symbols that predicts reading acquisition at the early stage of reading development. There are some practical implications for the current findings. In Hong Kong, the instruction of learning to read Chinese adopts a look and say approach (Ho & Bryant, 1997a) without any explicit emphasis on one syllable one character correspondence. In Mainland China, the instruction of finger-pointing reading is discouraged by the government (Ministry of Education of the People's Republic of China, 2011). Obviously, the benefit of accurately locating the characters for spoken syllables for early readers needs to be given full attention by educators and parents. Additionally, the study has generated an early predictor of reading development that might be helpful in identifying reading difficulties or developmental dyslexia.

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