Learning to Read Chinese: The Relative Roles of Phonological Awareness and Morphological Awareness

By

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Abstract

Phonological awareness and morphological awareness have been shown to affect Chinese children's reading development. Previous studies conducted in Hong Kong, which required children to read two-character words only or a mixture of single-character and two-character words in a Chinese reading test, exclusively found that morphological awareness was more important than phonological awareness in Chinese reading. The studies conducted in China and Taiwan, which measured Chinese reading only at the single-character level, revealed that morphological awareness and phonological awareness both had their unique contributions to Chinese reading. One possible reason for these somewhat inconsistent results may lie in the fact that reading two-character words presumably involves the analysis of morphological structures, which is rarely engaged in single-character reading. To address the inconsistency in previous findings, the present study aims to separately examine single-character reading and two-character reading among Chinese children in Taiwan, and how phonological awareness and morphological awareness affect the two aspects of Chinese reading. In addition, phonetic radical awareness and semantic radical awareness are also important in learning to read Chinese and theoretically can be fostered by phonological awareness and morphological awareness, respectively. Given this, radical awareness could possibly mediate the relationship between phonological awareness/morphological awareness and Chinese reading. This mediation issue is also investigated in the present study.

In this study, a total of 109 monolingual Chinese third graders in Taiwan were administered a battery of tests measuring phonological awareness (onset-rime awareness), morphological awareness (homophone awareness and morphological construction), phonetic radical awareness, semantic radical awareness, vocabulary knowledge, and abilities of single-character and

two-character reading. A series of multiple regression analyses and path analyses were conducted to analyze the data. It was found that morphological awareness played a greater role than phonological awareness in both single-character and two-character reading. In addition, phonetic radical awareness completely mediated the relationship between phonological awareness and single-character reading, whereas semantic radical awareness only partially mediated the relationship between morphological awareness and two-character reading. The results are explained from the linguistic, orthographic and developmental perspectives.

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Chapter I: Introduction

In the past few decades, phonological awareness has received much attention in reading research (e.g., Adams, 1990; Goswami & Bryant, 1990). In contrast, morphological awareness has not been extensively discussed in the studies of reading acquisition until recently. This dichotomy may be due to the traditional view that reading skill involves word decoding, which requires the mapping from print to sound (Gough & Tunmer, 1986). Phonological awareness, the ability to reflect on and manipulate the phonological components of a spoken word, is assumed to contribute to word decoding to because it helps children appreciate the association between print and sound (Swank & Catts, 1994). On the other hand, morphological awareness, "the ability to reflect upon and manipulate morphemes and employ word formation rules in one's language" (Kuo & Anderson, 2006, p. 161), is not necessarily involved in the print-to-sound mapping process; thus, its role in reading has been neglected. However, the orthography of a language represents not only phonology but also morphology, leading many current researchers to consider the importance of morphological awareness in reading development. For example, Carlisle, McBride-Chang, Nagy and Nunes (2010) did an integrative review on morphological awareness in six different languages (e.g., English, Chinese, Dutch, Danish, French and Norwegian) and found that morphological awareness instruction can facilitate children's understanding of word meanings.

It has been suggested that the nature of a script determines the extent to which different types of metalinguistic awareness (e.g., phonological awareness and morphological awareness) influence children's reading development (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2007; Nagy & Anderson, 1998). For example, alphabetic English uses letters to represent phonemes in words, but the concept of letter-phoneme correspondence is inapplicable to logographic Chinese,

which employs characters to represent morphemes and syllables in words. Due to the script difference, phonological awareness should be more related to English reading (Adams, 1990), while morphological awareness should be more important in Chinese reading development. However, a large body of research on Chinese children has documented the importance of phonological awareness in early Chinese reading development. Relatively few studies have examined the role of morphological awareness in Chinese reading. The primary goal of the present study is thus to explore the relative roles of phonological awareness and morphological awareness in learning to read Chinese among children in Taiwan.

Chapter II: Phonology, Script and Morphology in Mandarin Chinese

To understand the relative contributions of phonological awareness and morphological awareness to Chinese reading development among Mandarin-speaking children in Taiwan, it is necessary to understand the phonology, script and lexical structure of Mandarin Chinese.

Phonology

According to Fung (2009), Mandarin Chinese has 22 consonants and 12 vowels. The 22 consonants can be distinguished from one another by six places and seven manners of articulation. The consonant inventory of Mandarin Chinese is given in Table 1.

Table 1. *Consonants in Mandarin Chinese*

Manners \ Places	Bilabial	Labiodental	Dental	Retroflex	Palatal	Velar
Plosive Unaspirated	b /p/		d /t/			g /k/
Plosive Aspirated	p /p^h/		t /t^h/			k /k^h/
Fricative		f /f/	s /s/	sh /ʂ/ r /ʐ/	x /ɕ/	h /x/
Affricate Unaspirated			z /ts/	zh /tʂ/	j /tɕ/	
Affricate Aspirated			c /ts^h/	ch /$tʂ^h$/	q /$tɕ^h$/	
Nasal	m /m/		n /n/			ng /ŋ/
Liquid			l /l/			

Note. IPA symbols are between slashes, and the *Pinyin* symbols are provided on the left.

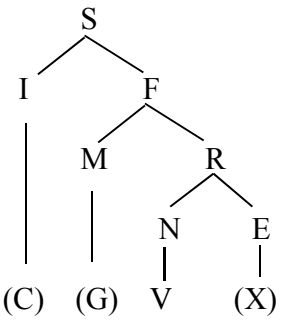
The 12 surface forms of the Mandarin vowels are given in Table 2.

Table 2. *Vowels in Mandarin Chinese*

	Frontness (front ←→back)					
Highness	i [ɿ,ʅ]	i [i]	ü [ü]			u [u]
		e [e]		e [ə]	e [ɣ]	o [o]
			e [ɛ]			
				a [a]	a [ɑ]	

Note. IPA symbols are between the square brackets, and the *Pinyin* symbols are provided on the left. The shading represents the round vowels.

In traditional phonology of Mandarin Chinese, a syllable is composed of two main parts: an initial, referring to the beginning consonant, and a final, referring to the remainder of the segmental sequence (Lin, 1989). The Mandarin final further consists of an optional glide plus a rime. There are three glides /j/, /ɥ/, /w/ in Mandarin, which are derived respectively from the high vowels /i/, ü/, /u/. The rime can be further divided into a nucleus and an ending (either a vocalic ending or a consonant ending). The structure of the Mandarin syllable is traditionally depicted as (C)(G)V(X) (*see* Figure 1, Lin, 1989).



S = Syllable

I = Initial; F = Final

M = Medial; R = Rime

N = Nucleus; E = Ending

C = Consonant; G = Glide

V = Vowel; X = glide/consonant/nasal

Figure 1. *Syllable structure in Mandarin Chinese*

No consonant clusters are allowed in a legal Mandarin syllable, making it relatively simple when compared to an English syllable, which allows consonant clusters, such as (C)(C)(C)V(C)(C)(C). In addition, lexical tones are obligatory in the Mandarin syllable and are carried by the final. Mandarin has four basic tones, along with one neutral tone, each of which distinguishes the meaning of the same syllable. The five lexical tones are Tone 0 (neutral), Tone 2 (rising), Tone 3 (falling-rising) and Tone 4 (falling). The most cited example in the linguistic textbook is 嗎 /ma0/ 'interrogative marker', 媽 /ma1/ 'mother', 麻/ma2/ 'marijuana', 馬/ma3/ 'horse', and 罵/ma4/ 'scold'. There are only 1,300 distinct tonal syllables in Mandarin Chinese (Li, Anderson, Nagy & Zhang, 2002). The small number of syllables makes homophones highly prevalent in Mandarin Chinese. Packard (2000) estimated that a Mandarin syllable has an average of five homophones. For example, the tonal syllable, /yi1/, can transcribe the following morphemes: 一 'one', 依 'depend', 醫 'medicine', 衣 'clothes', 裔 'descendent'.

Script[1]

In Chinese, a character is composed of a syllable and represents a morpheme; therefore, Chinese is usually considered to be a morphosyllabic language (DeFrancis, 1984). There are about a total of 4,500 frequently-used characters in Taiwan (Liu, Chuang, & Wang, 1975). Chinese characters are composed of several strokes (e.g., 丶, 一, 丨, 丿, 乀, 乛, 亅), which further form different stroke-patterns (e.g., 幺, 辶, 厶, 尸, 勹). Chinese characters can be classified into six etymological types: pictographs, simple indicatives, compound indicatives, phonograms, associate transformation and borrowing (Liang, 1959). About 80% of Chinese characters are phonograms consisting of a phonetic radical, conveying phonological information,

[1] There are two main dialects in the Chinese language, i.e., Mandarin and Cantonese. Mandarin is mainly spoken in Taiwan and Mainland China, and Cantonese is mainly spoken in Hong Kong. Although the phonological systems of the two dialects are different, the script (i.e., characters) is basically shared by Mandarin speakers and Cantonese speakers.

and a semantic radical, providing semantic information (for a review, see Wang, 1981). An example is 姨 /yi2/ ‘aunt’, which contains the phonetic radical 夷 /yi2/ and the semantic radical 女 ‘female-related’. According to Hoosian (1991), there are roughly 200 semantic radicals and 800 phonetic radicals in Chinese. The semantic radical and phonetic radical are not arbitrarily combined and positioned within a character but occupy a habitual position in a character; i.e., a semantic radical usually appears on the left or top in a character, while a phonetic radical usually appears on the right or bottom in a character.

The semantic radical can further be categorized into two types in terms of the degree to which it provides the semantic information for a character: a transparent semantic radical explicitly contributes to the meaning of a character carrying it, while an opaque semantic radical does not. For instance, the transparent semantic radical 女 ‘female-related’ is semantically related to the character 媽 ‘mother’, but the opaque semantic radical 土 ‘soil-related’ is semantically unrelated to the character 增 ‘increase’.

Similarly, a phonetic radical can provide different degrees of phonological information of a character containing it (Hue, 1992; Shu, 2003). For example, a phonogram whose pronunciation is the same as that of its phonetic radical irrespective of the tonal difference is called a regular phonogram, such as 碼 /ma3/ ‘yard’, which pronounces the same as its phonetic radical 馬 /ma3/. A phonogram which shares either the onset or rime with its phonetic radical irrespective of the tone is called a semi-regular phonogram, such as 睛 /jing1/ ‘eye’, which shares the rime /-ing1/ with its phonetic radical 青 /qing1/. A phonogram whose onset and rime are different from those of its phonetic radical is called an irregular phonogram, such as 怡 /yi2/ ‘happy’, which has a different pronunciation from that of its phonetic radical 台 /tai2/. In ancient Chinese, the phonetic radical of an irregular phonogram, like the phonetic radical of a regular

phonogram, also conveys phonological information; however, the evolvement of the Chinese language disables this sound cueing function. Shu, Chen, Anderson, Wu and Xuan (2003) estimated that only 23-26% of the phonograms in Mandarin Chinese are regular.

Compared to the low predictability of the phonetic radical in the pronunciation of a phonogram, the semantic radical provides a more reliable cue to the meaning of a phonogram. For example, most of the 184 commonly-used phonograms with the semantic radical, 扌'hand-related' (e.g., 打 /da3/ 'hit', 握 /wo4/ 'hold', 摇 /yao2/ 'shake', 推 /tuei1/ 'push', 拉 /la1/ 'pull', etc.), are related to the meaning of "hand" (Zhu, 1987 cited from Ho, Ng, & Ng, 2003). In addition, Shu (2003) reported that the meanings of about 88% of the phonograms are semantically related to their semantic radicals, while the meanings of only 9% of the phonograms cannot be inferred from their semantic radicals.

Morphology

In Chinese, around 70% of words are poly-morphemic compounds composed of two or more single morphemes (Institute of Language Teaching and Research [of China], 1986). According to the *Table of Frequent Words in Modern Chinese* (People's Republic of China, State Language and Letters Committee, 2008), 72.05% of compound words in modern Chinese are composed of two morphemes, while 5.68% of compound words contain only one morpheme. The way in which morphemes are combined to form a word in Chinese tends to be regular and informative such that the meanings of most Chinese compound words are readily predictable from the meanings of their constituent morphemes (Packard, 2000; Chen, Hao, Geva, Zhu, & Shu, 2009). For example, the meaning of the compound word 大人 /da4ren2/ 'adult' is derivable from its constituent morphemes, 大 /da4/ 'big' and 人 /ren2/ 'person'. This type of compound word is called "transparent compound". There is another type of compound word in

Chinese called “opaque compound”, whose meaning cannot be directly derived from its constituent morphemes. For example, the meaning of the opaque compound, 花生 /hua1sheng1/ ‘peanut’, is not derivable from its constituent morphemes, 花 /hua1/ ‘flower’ and 生 /sheng1/ ‘born’. Like English compound words, where the right morpheme functions as the head specifying the category of the word and the left morpheme functions as the modifier specifying the subcategory of the word (Clark, Gelman, & Lane, 1985), Chinese compound words are also characteristic of the “right headness”. For example, the compound word, 蠟筆 /la4bi4/ ‘crayon’, is composed of the right morpheme 筆 /bi3/ ‘pen’ modified by the left morpheme 蠟 /la4/ ‘wax’.

Chapter III: Literature Review

Theories and Models of Word Reading

The central concern of the present study is Chinese character/word reading. However, it is important to introduce theories of early reading development and models of skilled word reading that are established based on alphabetic languages and then apply these theories and models to the context of Chinese reading. Specifically, the stage theory and Dual Route Cascaded Model will be illustrated in this section.

Stage Theories of Early Reading Development

The developmental theory of word recognition that has been extensively discussed in the literature on beginning reading is Frith's (1985) three-stage theory. Basically, this theory proposes three stages children go through before becoming a proficient reader: the logographic stage, the alphabetic stage and the orthographic stage. At the logographic stage, words are recognized based on the most salient visual cues of the words. At the alphabetic stage, words are recognized by converting the component letters to their corresponding sounds and blending those sounds to obtain the pronunciation. At the orthographic stage, words are recognized automatically by identifying the orthographic patterns (e.g., letter sequence) without the mediation of the letter-sound conversion process. A more recent stage theory of word recognition was proposed by Ehri (1995), who argued for four stages of development. In addition to the three stages proposed in Frith's (1985) theory, Ehri (1995) added one more stage between Frith's logographic stage and alphabetic stage, i.e., partial alphabetic stage. At the partial alphabetic stage, children use partial phonetic cue to recognize words. For example, some children use the letter name to read a word, such as reading *beat* by combining the names of the first letter, *b*, and last letter, *t*.

Referring to Frith's (1985) three-stage theory, Ho, Chan, Lee, Tsang, and Luan (2004) found that character reading acquisition in Chinese also proceeds through three similar stages. At the logographic stage, Chinese children learn to read characters solely by rote. Phonological and visual memories are thus important for children to remember the sounds of many new characters, discriminate and memorize the different visual forms of characters, and further associate the visual form of a character to its phonological form. For the second stage, Ho et al. (2004) relabeled Frith's (1985) "alphabetic" stage to the "cipher" stage to reflect the fact that Chinese characters, unlike English words, do not contain alphabets but are composed of stroke patterns that can be considered ciphers. At the cipher stage, with the increasing number of characters learned at the logographic stage, Chinese children begin to recognize the recurring stroke patterns of characters (i.e., radicals) that serve a certain function (e.g., phonological and semantic functions), and make use of the radicals to read new characters. At the orthographic stage, the reading of characters become more automatic with no radical analysis involved. Naming speed is usually used as an index of the efficiency in the orthographic process of Chinese characters. Similarly, Hong (1999), who reviewed several works (e.g., Chall, 1983; Rayner & Pollatse, 1989; Wan, 1991), suggests that Chinese children also experience three stages in developing character recognition skill, which approximately correspond to the three stages proposed by Ho et al. (2004) and Frith (1985). Hong (1999) further specified the ages when the three corresponding stages occur among children in Taiwan, i.e., logographic stage: before age six, cipher stage: age 6-7 and orthographic stage: age 7-9.

Models of Word Recognition

After children pass through the logographic, alphabetic/cipher and orthographic stages, they may develop more efficient word recognition skills, which are captured in Coltheart, Rastle,

Perry, Langdon and Ziegler's (2001) Dual Route Cascaded (DRC) model. This model has been widely cited as the prevailing model of word reading in alphabetic languages. The basic idea of this model is that there are three independent routes to word recognition: a lexical-semantic route, a lexical nonsemantic route, and a non-lexical grapheme-phoneme-correspondence (GPC) route. The lexical semantic route is engaged in obtaining the pronunciation of a word from its semantic representation, the lexical nonsemantic route is engaged in deriving the pronunciation of a word directly from its orthographic representation without resorting to its meaning, and the non-lexical GPC route is engaged in reading novel words or nonwords by mapping the letters onto phonemes and combining the phonemes to obtain the pronunciation. The two lexical routes in question allow one to search his or her mental lexicon for the spellings and pronunciations of the letter patterns that are contained in the words to be read and are especially important for reading irregular words that cannot be pronounced solely based on the GPC rules. On the contrary, the non-lexical GPC route involves no reference to the mental lexicon; instead, it allows one to take advantage of the GPC rules (at the sub-lexical level) to obtain the pronunciation of a novel word or nonword.

The DRC model developed based on alphabetical languages, as pointed out by Shu, Meng, Chen, Luan and Cao (2005), may not readily apply to Chinese character recognition due to the unique logographic nature in Chinese: the strokes of a Chinese character do not represent its constituent phonemes as letters represent phonemes in English, and the mapping of orthography to phonology in Chinese is not at the phonemic level, but at the syllable level. The nonexistence of the grapheme-phoneme correspondences in Chinese invalidates the function of the non-lexical GPC route of the DRC model in explaining Chinese reading. In addition, Yin and Weekes (2003) suggested that the lexical-semantic route to reading should be dominant in dealing the

morphographic nature of Chinese. In light of the inapplicability of the DRC model to Chinese reading, Yin and Weekes (2003), based on several cases of Chinese dyslexia, proposed a "triangle model" to describe how Chinese characters can be read. This "triangle model" (shown in Figure 2) consists of three types of representations (i.e., orthographic representation, phonological representation and semantic representation) and two independent bi-directional pathways that are linked to the orthographic representation: a lexical-semantic pathway, which allows reading words for meaning; and a non-semantic phonological pathway, which connects the orthographic representations (i.e., strokes, radicals, and characters) to the phonological representations (i.e., syllables, rimes, and tones). The two pathways are independent of each other in terms of function and development. Unlike the non-lexical GPC route in the DRC model, which only can be implemented at the sub-lexical level, the non-semantic phonological pathway in the triangle model can function both at the character (lexical) and the sub-character (sub-lexical) levels. In this triangle model, when a Chinese character is presented to a reader, its orthographic representation activates not only the target character and other semantically-related characters through the lexical semantic pathway but also the pronunciation of the target character, along with the pronunciation of its phonetic radical via the non-semantic phonological pathway. The activated semantic and phonological representations of the target character place constrains on each other such that the target character can be correctly recognized from several candidates. This mutual constraint of the semantic and phonological representation is supported by the cases of deep and surface dyslexia in Chinese (Law & Or, 2001; Law, Wong, & Chiu, 2005; Yin & Butterworth, 1992). For example, deep dyslexia, which is characteristic of semantic errors in reading, is caused by the impairment of the non-semantic phonological pathway such that no phonological constraints are put on the semantically-related incorrect characters activated

through the lexical semantic pathway, leading to semantic errors. On the contrary, surface dyslexia, which is characteristic of phonetic regularization errors, is caused by the impairment of the lexical semantic pathway such that no semantic constraints are placed on the incorrect pronunciations of the character activated by the non-semantic phonological pathway, resulting in phonetic regularization errors.

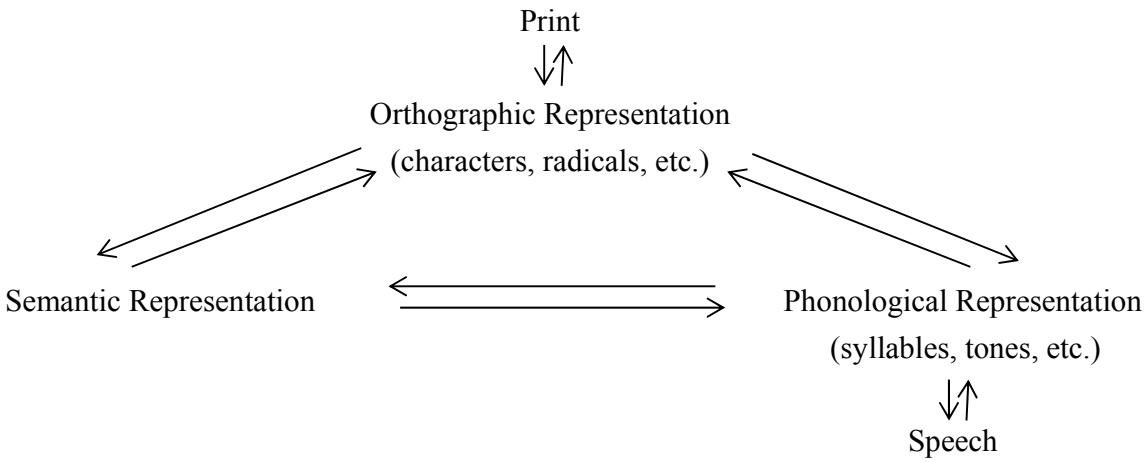


Figure 2. *Triangle Model of Chinese Reading*

Phonological Awareness, Phonetic Radical Awareness and Chinese Reading

Phonological awareness refers to the ability to detect and manipulate the phonological components (e.g., syllables, onsets, rimes and phonemes) of spoken words (Oakhill & Kyle, 2000). There are basically three levels of phonological awareness in terms of phonological units involved, i.e., syllable awareness, onset-rime awareness and phonemic awareness (Trieman & Zukowiski, 1991). Syllable awareness develops earlier than onset-rime awareness, which, in turn, develops earlier than phonemic awareness (Goswami & Bryant, 1990). While the development of syllable awareness and onset-rime awareness is affected by oral language experience, such as vocabulary knowledge, phonemic awareness has been

shown to be fostered by reading experience (Anthony & Francis, 2005).

Phonological awareness is known for its strong influence on alphabetic reading development (e.g., English) owing to the predictable relationship between graphemes and phonemes in alphabetic languages (Adams, 1990; Bradley & Bryant, 1983). Chinese is traditionally considered to be a language with a very opaque orthography because the symbol-sound correspondence is highly inconsistent and might be arbitrary. Given this traditional impression, using phonological awareness is assumed to be an inefficient way to read Chinese. In addition, Chinese characters are composed of visually complex symbols, leading some researchers to believe that visual processing skills may be more essential than phonological awareness in learning to read Chinese (e.g., Hung & Hanley, 1995). However, over the past two decades, a burgeoning body of research has established a firm relationship between different levels of phonological awareness (i.e., syllable awareness, onset-rime awareness, and tone awareness) and learning to read Chinese in three major Chinese societies (i.e., Taiwan, China and Hong Kong) even after some other cognitive and reading-related measures (e.g., IQ, vocabulary size, alphabetic experience, etc.) are considered (e.g., Ho, 1997; Ho & Bryant, 1997; Hu & Catts, 1998; Huang & Hanley, 1997; Leong, Cheng, & Tan, 2005; McBride-Chang & Ho, 2000; McBride-Chang & Kail, 2002; Newman, Tardif, Huang, & Shu, 2011; Shu, Peng, & McBride-Chang, 2008; Siok & Fletcher, 2001).

The importance of phonological awareness in learning to read Chinese is evident when we consider how Chinese children in Taiwan and China learn to read at the outset. In Taiwan, school teachers teach children a phonetic alphabet called *Zhuyin Fuhao* (hereafter, *Zhuyin*) as an aid to read Chinese characters at the very beginning of primary school. *Zhuyin* roughly transcribes spoken sounds at the onset-rime level and is printed alongside the new characters in the reading

textbooks. Children are instructed to write characters together with *Zhuyin*. The goal of the *Zhuyin* instruction is to enable children to write a character when presented with its corresponding *Zhuyin* and vice versa. In China, children learn a different phonetic alphabet called *Hanyu Pinyin* (hereafter, *Pinyin*) to read Chinese characters. The *Pinyin* system borrows English letters to represent individual phonemes. *Pinyin* is printed under each character in the textbooks. Children in China are expected to be familiar with the associations between characters and their corresponding *Pinyin* after completing primary school. Given the alphabetic nature of the phonetic alphabet (i.e., *Zhuyin* and *Pinyin*) and the importance of phonological awareness in reading an alphabetic script (Swank & Catts, 1994), Hu and Catts (1998) argued that Chinese children with better phonological awareness should outperform those with poorer phonological awareness in using the phonetic alphabet. Better decoders of the phonetic alphabet (i.e., *Zhuyin* and *Pinyin*) theoretically should be among the better readers of Chinese characters (e.g., Ko & Lee, 1997; Siok & Fletcher, 2001). In other words, phonological awareness may indirectly influence reading development of Mandarin-speaking children in Taiwan and China through its direct effect on the decoding of the phonetic alphabet. However, Hu and Catts (1998) further found that phonological awareness still accounted for the residual variance in Chinese reading after the experience with the phonetic alphabet was considered, suggesting that the relationship between phonological awareness and Chinese reading cannot be completely explained by children's experience with the phonetic alphabet.

A more critical piece of evidence showing the usefulness of phonological awareness in Chinese reading is that most Chinese characters contain a phonetic radical, which provides phonological information. Studies have shown that the knowledge of phonetic radicals may

facilitate Chinese children in learning to read. For example, Wu, Zhou, and Shu (1999) conducted a naming experiment, which required a group of Mandarin-speaking children to name the target character (e.g., 美 /mei3/ 'beautiful') as quickly as possible after primed by a phonogram (e.g., 海 /hai3/ 'sea') whose phonetic radical (e.g., 每 /mei3/) was homophonic to the target (i.e., the experiment condition) or by a phonogram (e.g., 低 /di1/ 'low') whose phonetic radical (e.g., 氐 /di1/) was not homophonic to the target (i.e., the control condition) . A facilitatory priming effect was observed only in the experiment condition but not in the control condition, suggesting that Mandarin-speaking children may be aware of the phonetic radical and use it to activate the phonological representation in the primed naming task. However, the facilitatory effect on naming the target character was only demonstrated in the low-frequency prime phonograms but not in high-frequency prime phonograms. Ho, Ng, and Ng (2003) found that the function of the phonetic radical and knowledge of the sound value of the phonetic radical helped Cantonese-speaking children in reading Chinese characters. Ho and Bryant (1997) reported that Cantonese-speaking children in Hong Kong had better performance on reading regular phonograms, which were pronounced the same as their phonetic radical than on reading irregular phonograms, which differed from their phonetic radicals in pronunciation, suggesting the awareness of phonetic radical in reading Chinese characters. Anderson, Li, Ku, Shu and Wu (2003) examined both Mandarin-speaking and Cantonese-speaking children's ability to read different types of unfamiliar phonograms: a regular phonogram, whose syllable and tone are identical to those of its phonetic radical; a tone-different phonogram, whose tone, but not syllable, is different from that of its phonetic radical; an onset-different phonogram, whose onset, but not rime and tone, is different from that of its phonetic radical; and an unknown phonogram, whose phonetic radical is totally unknown to children. They found that children could read significantly

more regular phonograms, tone-different phonograms and onset-different phonograms than unknown phonograms, suggesting that Chinese children are able to use the phonetic radical to predict the pronunciation of a less familiar character. Among the four types of phonograms studied in Anderson et al. (2003), the reading of onset-rime phonograms may require phonological awareness to a great extent. For example, Hu and Catts (1998) argued that the reading of a less familiar onset-different phonogram, such as 穗 /sui4/ 'ear of wheat', may depend partially on the phonology of the rime of its phonetic radical, 惠 /hui4/. Only when children are able to extract the rime (i.e., /-ui/) from the phonetic radical, 惠 /hui4/ (i.e., analytical phonological awareness) and combine the rime extracted with other new onsets (i.e., synthetic phonological awareness) can they read the character, 穗, with higher accuracy than when they are unable to do so because the extraction of the rime of the phonetic radical at least can reduce the number of possible pronunciations of a phonogram. This requires onset-rime awareness.

The process of extracting the rime from a phonetic radical, as pointed out by Hu and Catts (1998), may be complicated by the fact that the segmentation of the rime from a phonetic radical cannot depend on the analysis of the graphic whole of the phonetic radical because unlike English words, Chinese characters cannot be separated into parts that represent its rime. For example, neither of the two stroke patterns, 主 or 月, in the phonetic radical, 青 of the Chinese character, 晴 /jing1/ 'eye', represents the rime. However, in alphabetic English, the three letters, *c*, *a* and *t* of the word, *cat*, represent the component sounds /k/, /æ/ and /t/ of that word, respectively. In other words, there is a graphic cue of the pronunciation in an English word, but this kind of cue is lacking in Chinese characters. Thus, one has to analyze the sound structure of the phonetic radical directly from its

acoustic whole without any graphic support. Given this, problems with phonological awareness could impede the recovery of the rime of a phonetic radical. This idea is supported in Ho and Bryant's (1997) study, where Chinese children's reliance on the phonetic radical as a sound cue (i.e., phonetic radical awareness) in reading unfamiliar phonograms was found to be correlated with their phonological awareness. In addition, children with better phonological awareness are theoretically more able to detect phonological similarity between an unfamiliar phonogram and its phonetic radical (e.g., rhyming or alliteration), and thus will be more easily aware of the function of the phonetic radical in predicting the pronunciation of an unfamiliar phonogram, which in turns help children learn phonetic radicals. Taken together, the observed relationship between phonological awareness and Chinese reading could be mediated by phonetic radical awareness.

Morphological Awareness, Semantic Radical Awareness and Chinese Reading

One widely-cited definition of morphological awareness is proposed by Carlisle (1995), who defined morphological awareness as "children's conscious awareness of the morphemic structure of words and their ability to reflect on and manipulate that structure" (p. 194). McBride-Chang, Wagner, Muse, Chow and Shu (2005) gave a similar definition, i.e., "awareness of and access to the meaning and structure of morphemes in relation to words" (p. 417). A close comparison of the two definitions reveals that neither of the definitions can capture the whole picture of morphological awareness. For example, Carlisle's definition lacks one important concept, i.e., the awareness of the meaning of morphemes. Similarly, McBride-Chang's definition does not include the concept of manipulation of the morphological structure. The manipulation of the language structure is an important aspect of metalinguistic awareness, as defined by Tunmer and Herriman's (1984), "the ability to reflect upon and manipulate the structural features of language, treating language itself as the object of thought, as

opposed to simply using the language system to comprehend and produce sentences" (p.16). Taken together, a comprehensive definition of morphological awareness should include two important aspects: a) the awareness of the morphemes and morphological structure, and b) the manipulation of the morphemes and morphological structure. A more complete definition of morphological awareness that includes the two aspects was proposed by Kuo and Anderson (2006) as "the ability to reflect upon and manipulate morphemes and employ word formation rules in one's language" (p. 161).

As far as Chinese is concerned, two types of morphological awareness have received the most attention in the Chinese literature due to the high prevalence of homophones and compound words in the Chinese language: homophone awareness (Chung & Hu, 2007; Liu, McBride-Chang, Wong, Shu, & Wong, 2013; McBride-Chang et al., 2003) and compound awareness (Chen, Hao, Geva, Zhu, & Shu, 2009; Liu et al., 2013; Zhou, McBride-Chang, Fong, Wong, & Cheung, 2012). Homophone awareness refers to the ability to distinguish morphemes with the same pronunciation, while compound awareness deals with the understanding and manipulation of the morphological structure rules.

Compared to studies on the relationship between phonological awareness and Chinese reading ability, studies that examined morphological awareness and its relation to reading ability in Chinese children are relatively scarce. These studies found a significant effect of morphological awareness on early Chinese reading among children in Taiwan, China and Hong Kong (e.g., Chen et al., 2009; McBride-Chang et al., 2003; Tsai, 2009). There are at least three reasons to believe that morphological awareness is indispensable to Chinese reading success. First, Chinese is categorized as a morphosyllabic language (DeFrancis, 1984), where a character represents a morpheme; thus, one fundamental process underlying Chinese reading is to map characters onto morphemes, which should draw greatly upon one's awareness of morphemes

within a word in the oral language.

Second, as shown earlier, around 72.05% of Chinese words are compound words made up of two morphemes. The understanding of how morphemes can be legally combined to form a word is crucial in learning to read Chinese characters/words because it provides a way to analyze morphologically complex words. For example, suppose a child can recognize the following printed compound words containing the morpheme, 球 /qiu2/'ball', such as 桌球 /zhuo1qiu2/ 'table tennis', 棒球 /bang4qiu2/ 'baseball', 足球 /zu2qiu2/ 'soccer', 排球 /pai2qiu2/ 'volleyball' and 羽球 /yu3qiu2/ 'badminton', but not the word 籃球 /lan2qiu2/ 'basketball' due to the unknown character, 籃; however, the spoken form of 籃球 /lan2qiu2/ is in the child's mental lexicon. The reading of the unfamiliar printed compound word, 籃球, may require the child to be aware that 籃球 is formed with the same morphological structure as 桌球, 棒球, 足球, 排球 and 羽球, i.e., "__ + 球," meaning some kind of ball. Then, the child can search the "ball" category in his or her mental lexicon for the lexical item that has not been associated with any printed form. In this example, the child can exclude /zhuo1qiu2/, /bang4qiu2/, /zu2qiu2/, /pai2qiu2/ and /yu3qiu2/ as the possible readings of 籃球 because these known words have had their corresponding printed words, i.e., 桌球, 棒球, 足球, 排球, and 羽球, respectively. Given that /lan2qiu2/ in the child's mental lexicon has no associated printed form, the printed word, 籃球, can possibly be read as /lan2qiu2/, which in turn aids the reading of the unknown character 籃. Although this way cannot guarantee 100% accuracy in reading unknown characters/words, it at least can reduce the number of possible readings, resulting in a higher chance to make the right guess. On the other hand, a child who is oblivious to the morphological structure of a compound word (i.e., the lack of compound awareness) may have greater difficulty guessing how that word can be read.

Third, the richness of homophones in the Chinese language may drive Chinese children to resort to homophone awareness in distinguishing different characters with the same pronunciation (McBride-Chang et al., 2003). For example, the syllable /zhu4/ is shared by several different characters/morphemes in different words, such as 住家 /zhu4-jia1/ 'house', 助手 /zhu4-shou3/ 'assistant', 祝福 /zhu4-fu2/ 'bless', and 注意 /zhu4-yi4/ 'attention', etc. To successfully distinguish the four homophonic characters mentioned above, it is necessary to have the awareness that the four homophonic characters represent four different morphemes. Like compound awareness, homophone awareness can also help children reduce the number of possible readings of an unfamiliar character. For instance, when reading the unknown word, 懇求 /ken3qiu2/ 'request earnestly', which contains a known morpheme, 求 /qiu2/ 'request', a child who is able to distinguish the meaning of 求 from those of other morphemes with the same pronunciation, such as 球 /qiu2/ 'ball', can more easily avoid the members that belong to other morphemes (e.g., 桌球, 棒球, 足球, 排球 and 羽球) as the possible readings for 懇求 than when he or she is unable to do so. As a consequence, the possibility of correctly reading the unknown character 懇 in the unfamiliar word 懇求 will be increased. From the arguments given above, it seems that unlike phonological awareness, which has an impact on character reading independent of word contexts, morphological awareness exerts its influence on character reading with an aid of word contexts.

In addition to morphological awareness, semantic radical awareness has also been shown to contribute to Chinese reading. Research has revealed that character reading may depend on the processing of the semantic radical. For example, Feldman and Siok (1999), who adopted the priming paradigm in a lexical decision task, found that the semantic attribute (but not the graphic attribute) of a semantic radical and the frequency at which a semantic radical appears in different

characters were the two factors that affected character recognition. A similar result was obtained in another priming study, where Zhou, Peng, Zheng, Su, and Wang (2013) found that when primed with a low-frequency character (e.g., 弥 /mi2/ 'full') whose semantic radical (弓 'bow-related') was semantically related to the target character (e.g., 箭 /jian4/ 'arrow'), Mandarin speakers named the target character significantly faster than when primed with a low-frequency character (e.g., 称 /cheng4/ 'match') whose semantic radical (禾 'crop-related') was semantically unrelated to the target character. Ho, Ng and Ng (2003) found that the positional information as well as the semantic category of a semantic radical determined how well Cantonese-speaking children read Chinese characters. Shu and Anderson (1997) also found that Mandarin-speaking children as young as third grade could identify an unknown printed character representing one morpheme of a familiar spoken two-morpheme word based on the semantic radical of that unknown character. Furthermore, children were found to be more able to derive the meaning of a new character when its semantic radical was familiar to them than when it was not. Taken together, the recognition or reading of a Chinese character, low-frequency character in particular, may require semantic radical awareness.

According to Li, Anderson, Nagy, and Zhang (2002), semantic radical awareness, the sensitivity to the morphemic structure of Chinese characters, can be considered to be one type of morphological awareness that specifically deals with print. In this sense, semantic radical awareness is somewhat different from orally-based morphological awareness that was adopted in most previous studies on Chinese reading development. To distinguish the two types of morphological awareness in the present study, orally-based morphological awareness will be simply referred to as morphological awareness, while print-based morphological awareness will be specifically referred to as semantic radical awareness. Studies have shown that Chinese

children start to develop their morphological awareness before learning to read (Chung & Hu, 2007), but the development of semantic radical awareness requires some accumulation of reading experience. In other words, morphological awareness develops earlier than semantic radical awareness in the very beginning of reading development. Given the differential sequences of development of morphological awareness and semantic radical awareness, it is possible that earlier-developing orally-based morphological awareness may influence children's development of later-developing print-based semantic radical awareness such that children who are more aware of the meaning of a morpheme from the oral language experience should be more readily able to learn the meaning of the semantic radical of a printed character representing that morpheme. However, as pointed out by McBride-Chang et al. (2003), so far no study has really looked at the extent to which morphological awareness predicts semantic radical awareness; thus, this issue remains to be explored.

If morphological awareness is found to predict semantic radical awareness, then the relationship between morphological awareness and Chinese reading observed in previous studies could possibly be mediated by semantic radical awareness. A possible mediating mechanism here is that children who have better morphological awareness are better equipped with semantic radical awareness, which, in turn, helps them narrow down the number of possible readings of an unknown printed character. For example, suppose a child knows the meaning and pronunciation of the spoken words constructed with the morpheme, 求 /qiu2/ 'request', such as 請求 /qing3qiu2/ 'request politely', 要求 /yao1qiu2/ 'demand', 祈求 /qi2qiu2/ 'invoke', 乞求 /qi3qiu2/ 'beg', 哀求 /ai1qiu2/ 'beg piteously', and 懇求 /ken3qiu2/ 'request earnestly', but they have not learned the written forms of those words except for the shared morpheme, 求 /qiu2/. When encountering the printed word, 懇求, whose first character is unknown, the child

can distinguish the morpheme 懇 from other morphemes that also come along with 求 /qiu2/ (e.g., 請, 要, 祈, 乞, 哀) by being aware that its semantic radical 心 'heart' is more related to the meaning of the morpheme 懇 'earnestly' than to the meanings of the other morphemes that also co-occur with 求. On the other hand, poor morphological awareness may limit children's ability to rely on semantic radical awareness in reducing the number of possible readings of an unknown printed character, thus decreasing the possibility of getting the correct reading of that character.

The Roles of Phonological Awareness and Morphological Awareness in Chinese Reading in Taiwan, China and Hong Kong

A good way to determine the relative roles of phonological awareness and morphological awareness in character/word reading development in Chinese children is to simultaneously include both phonological awareness and morphological awareness within a single study. Doing so allows the researcher to tease apart the unique contribution of phonological awareness and morphological awareness to reading by controlling for the common variance in reading that is shared by phonological awareness and morphological awareness. This section will briefly review some major studies that examined Chinese children's phonological awareness and morphological awareness simultaneously and their relationships with character/word reading development in Taiwan, China and Hong Kong.

Taiwan

A few studies conducted in Taiwan have looked at the relative roles of phonological awareness and morphological awareness in Chinese reading. One of the few studies is Tsai's (2009) study, where a group of Taiwanese first graders were followed up for two years on their development of phonological awareness and morphological awareness, and the relations of

phonological awareness and morphological awareness to single-character reading. In this study, the phonological awareness measures were provided orally to the children through the sound blending, sound segmentation, sound deletion and sound oddity tasks, whereas the morphological awareness measures were provided in a written format through three semantic radical awareness tasks. It was found that morphological awareness bore a significantly stronger concurrent and longitudinal relationship with single-character reading than did phonological awareness; however, the written format of the morphological awareness measures (i.e., semantic radical awareness) might have boosted its contribution to reading, which also involves the decoding of the written language. In a more recent study, Hu (2013) orally assessed Chinese children's phonological awareness and morphological awareness. This study was aimed to explore the concurrent and longitudinal relationships between phonological awareness/morphological awareness and early Chinese reading among a group of Taiwanese third graders who were tracked to their fifth grade. In this study, children's phonological awareness as measured by a sound oddity task and a sound deletion task and morphological awareness as measured by a morphological construction task were obtained at grade 3, while their Chinese reading skills as measured by a single-character reading task were obtained at grade 3 and grade 5. The results revealed that phonological awareness contributed to single-character reading both concurrently at grade 3 and longitudinally at grade 5 over and above the contributions of morphological awareness and other reading-related skills, such as vocabulary, digit span, etc.; however, phonological awareness ceased to predict individual differences in grade 5 single-character reading after grade 3 character reading (i.e., reading auto-regressor) was controlled for. On the other hand, the unique contribution of morphological awareness beyond those of phonological awareness as well as other control variables to

single-character reading was not manifested until grade 5, and this contribution even survived the control of grade 3 character reading. It appears that there is a developmental shift from using phonological awareness to relying on morphological awareness in reading Chinese between grade 3 and grade 5 among Taiwanese children.

China

Shu McBride-Chang, Wu and Liu (2006) did a path analysis to examine the relative associations of phonological awareness and morphological awareness with single-character reading among a group of Beijing fifth and sixth graders with and without dyslexia. They found that morphological awareness significantly explained variance in single-character reading after the effects of vocabulary knowledge, naming speed and phonological awareness were taken into account. Phonological awareness also significantly explained variance in single-character reading after the effects of vocabulary knowledge, naming speed and morphological awareness were partialled out. The information on beta weight further indicated that morphological awareness had a stronger association with single-character reading than did phonological awareness. In another similar study, Chen et al. (2009) explored the contributions of both phonological awareness and morphological awareness to Chinese single-character reading in a group of first and second graders from Tianjing, China. The results revealed that children's morphological awareness was a significant predictor of Chinese single-character reading after controlling for the influence of rapid naming, vocabulary knowledge and phonological awareness. Furthermore, the authors found that only syllable awareness survived the control of other reading related measures, including morphological awareness, in predicting Chinese character reading performance. A more recent study conducted by Liu and McBride-Chang (2010) tested a group of third graders from Northeast China on their morphological awareness using a newly-created

test, i.e., an open-ended compounding production test, along with two traditional tests: the morphological construction and homophone awareness tests. After controlling for non-verbal IQ, phonological awareness and the two traditional morphological awareness measures, the authors found that this new compounding production test could account for a unique variance in Chinese single-character reading.

Most of the research findings presented above suggest that phonological awareness and morphological awareness have their own unique contributions to character reading in Mandarin-speaking children from China; however, it seems that morphological awareness has greater influence on mainland Chinese children's single-character reading ability than does phonological awareness.

Hong Kong

McBride-Chang et al. (2003) investigated the influences of phonological awareness and morphological awareness on the ability to read characters/words in Hong Kong kindergartners and second graders. The result of a hierarchical regression analysis indicated that morphological awareness accounted for all the variance in a reading test that contained both single- and two-character words that could be explained by phonological awareness and other reading-related skills (e.g., vocabulary, visual processing, speed naming). The results held for kindergartners, second graders, and the two groups combined. Tong, McBride-Chang, Shu and Wong (2009) studied the extent to which morphological awareness and phonological awareness uniquely predicted word reading in Hong Kong kindergartners. They found that once vocabulary knowledge and naming speed were statistically controlled, only morphological awareness, but not phonological awareness, was uniquely associated with two-character reading both concurrently and longitudinally. Another longitudinal study (Tong, McBride-Chang, Wong, Shu,

Retisma, & Rispens, 2011) followed a group of four-year-old Hong Kong kindergartners for two years and investigated their performances on a reading task which contained both single- and two-character words. The results showed that with age, vocabulary knowledge, non-verbal IQ, other reading-related constructs and reading performance at Time 1 statically controlled, the effect of Time 1 phonological awareness on the reading task was significant only at Time 2, but disappeared at Time 3 when children's reading skills improved; however, morphological awareness continued to be a significant predictor of reading task at both Time 2 and Time 3.

Given that the control for reading-related abilities significantly reduced the effect of phonological awareness but not morphological awareness on character/word reading ability in the studies cited above, morphological awareness appeared to be more crucial than phonological awareness in explaining individual differences in character/word reading development among Cantonese-speaking children in Hong Kong.

Possible Explanations for the Differential Roles of Phonological Awareness and Morphological Awareness in Chinese Reading in the Three Chinese Societies

The greater contribution of morphological awareness (relative to phonological awareness) to learning to read Chinese observed in children in China and Hong Kong may be explained by the richness of homophones in Mandarin (spoken in China) and Cantonese (spoken in Hong Kong). It has been estimated that a spoken Mandarin syllable represents an average of five morphemes (Packard, 2000), whereas a spoken Cantonese syllable represents an average of three morphemes (Chow et al., 2008). Given the one-to-many relationship between syllable and morpheme in Mandarin and Cantonese, it is not always reliable to distinguish characters/words with the same pronunciation simply by using phonological awareness. For example, telling the syllable, /zhu4/, in /zhu4yi4/ 'attention' from the same syllable, /zhu4/, in /zhu4fu2/ 'blessing'

should depend on morphological information, rather than phonological information, making morphological awareness more important than phonological awareness in learning to read Chinese. In addition, the low percentage of characters with a regular phonetic radical in Mandarin (i.e., 40% irrespective of the tone and 23%-26% with the tone considered; Shu et al., 2003) and Cantonese (i.e., 34% with the tone considered; Law, 1997), often renders the application of the phonetic radical to character reading inefficient, thus possibly downgrading the importance of phonological awareness in Chinese reading. However, the abundance in homophones and low percentage of regular characters in Mandarin should also make children in Taiwan rely greatly on morphological awareness in reading because they speak Mandarin as well. Then, why does morphological awareness not play a role in early Chinese reading but only contributes to later reading development among children in Taiwan, as observed in Hu's (2013) study? Hu (2013) argued that the difference in the amount of exposure to written words between children in Taiwan and children in Hong Kong may be the reason. Citing Carlisle's (2003) work, Hu (2013) argued that sufficient exposure to written words is necessary for morphological awareness to take effect in Chinese reading. Children in Hong Kong receive the reading instruction at age three (Li & Rao, 2000) and thus should be more exposed to written words than children in Taiwan, who receive the reading instruction at age six. This being the case, morphological awareness could affect Chinese reading very early among children in Hong Kong, whereas the influence of morphological awareness on Chinese reading is not manifested until a later age among children in Taiwan.

One may wonder why phonological awareness exerted its influence on children's reading in Taiwan and China but not in Hong Kong. This finding could not be attributable to the percentages of characters with a regular phonetic radical because they are comparably low in

Mandarin and Cantonese as shown above. One possible explanation is related to the relative complexities of the Mandarin and Cantonese syllable structures. Basically, both the Mandarin and Cantonese syllables are composed of an initial and a final (Mandarin: Lin, 1989; Cantonese: Lee et al., 1995); however, the rime of a Mandarin syllable is not the immediate syllabic constituent; rather, it is embedded in one of the immediate syllabic constituent (i.e., final, *see* Figure 1). This is not the case in the Cantonese syllable, where the rime happens to be the final, which is immediately dominated by the syllable. Therefore, a higher degree of phonological awareness is required to break off the highly-embedded rime from the Mandarin syllable (Hu & Catts, 1998), but this is not the case in Cantonese syllables. Another possible explanation may be related to the different formal reading instructions implemented in the three Chinese societies; i.e., a phonetic coding system (i.e., *Zhuyin* and *Pinyin*) is taught in Taiwan and China, while a "look-and-say" approach to character/word reading is taught in Hong Kong. The "look-and-say" approach encourages children to memorize the pronunciation of each character/word without relying on any type of phonetic coding system. The influence of the *Zhuyin* and *Pinyin* experience on character reading has been found by Chen and Yuen (1991), who reported that children in Taiwan and China read significantly more pseudo-phonograms than children in Hong Kong. The authors argued that the experience with *Zhuyin* and *Pinyin* might help children in Taiwan and China extract phonological information of a character more easily than children in Hong Kong, who lack such an experience. In other words, the experience with the phonetic coding system may encourage children in Taiwan and China to read characters via a phonological route because *Zhuyin* and *Pinyin* make the phonological structure of a character readily accessible to them. On the contrary, the "look-and-say" approach to character/word reading adopted in Hong Kong may mask the phonological structure of a character, which

inhibits children from using phonological awareness to read a character. In addition, compared to the instructions in the phonetic coding system, the "look-and-say" approach may direct children's attention more to the meaning of the character than to its sound components (e.g., onsets and rimes) because Chinese characters represent morphemes and syllables. In this case, morphological awareness could better help Hong Kong children in learning to read Chinese than phonological awareness.

Limitations of Previous Studies and Motivations of the Present Study

While many previous studies have explored the relative contributions of phonological awareness and morphological awareness to Chinese reading development, they yielded somewhat inconsistent results. Although the above explanations regarding the relative importance of phonological awareness and morphological awareness in reading Chinese in the three Chinese societies are theoretically sound, a closer examination of these studies shows that the reading measures are not comparable. Specifically, children in Taiwan and China were all tested on single-character reading only, whereas most studies in Hong Kong required children to read two-character words only or a mixture of single-character and two-character words in the same reading test. Liu, Chung, McBride-Chang and Tong (2010) found that Chinese children read single characters and two-character words differently. Specifically, reading single characters requires orthographic processing such that the structural relations of the component radicals in a character (i.e., the specific position a radical should be placed within a character) was analyzed. When reading a two-character word, Chinese children rely more on morphological processing. This may be because Chinese two-character words are not arbitrarily formed but are created following certain morphological rules (e.g., subordinate, coordinative, subject-predicate, and verb-object; Li & Thompson, 1981). On the contrary, single-character reading theoretically

involves little morphological analysis; therefore, morphological awareness should make little contribution to single-character reading. For the above reasons, the seemingly greater influence of morphological awareness on Chinese reading found in children in Hong Kong may solely reflect an experimental artifact. This issue has also been noticed in Liu et al.'s (2013) study but has not yet been systematically investigated in the current literature. In order to untangle this issue on the relative roles of phonological awareness and morphological awareness in Chinese reading, single-character reading and two-character reading should be examined separately. In addition, very few studies, if any, have examined whether the awareness of the phonetic radical and semantic radical mediates the relationship between phonological awareness/morphological awareness and learning to read Chinese. This potential mediating effect must be assessed by including tasks measuring phonetic radical awareness and semantic radical awareness. For the mediating relationship to be established, the effect of phonological awareness on phonetic radical awareness and the effect of morphological awareness on semantic radical awareness must be confirmed first in the present study.

One possible confound that can influence the relationship between phonological awareness/morphological awareness and reading is vocabulary knowledge. It has been suggested that vocabulary knowledge may mediate the relation of morphological awareness to reading (e.g., Chung & Hu, 2007; Liu et al., 2013). For example, Liu et al. (2013) found that lexical compounding and homophone awareness could facilitate Chinese children's vocabulary acquisition, which itself has a direct effect on word reading in Chinese. In addition, there is some indication that the development of phonological awareness could be a corollary of vocabulary growth (e.g., Metsala & Walley, 1998; Walley, Metsala, & Garlock, 2003). For example, the lexical restructuring model (Walley, Metsala, & Garlock, 2003) suggests that an increasing

number of phonologically similar words in the mental lexicon make word storage in long-term memory inefficient. In order to store words more efficiently, the representations of lexical items must become segmented, which, in turn, facilitates development of phonological awareness. Furthermore, vocabulary knowledge has also been found to foster reading development (Adams, 1990). Given the above considerations, vocabulary knowledge must be included as a control variable in the statistical analysis to assure that the relationship between phonological awareness/morphological awareness and Chinese reading, if observed, is not due to the effect of vocabulary knowledge.

In summary, the purposes of the present study were (1) to specify the relative contributions of phonological awareness and morphological awareness to different aspects of Chinese reading (i.e., single-character and two-character word reading); (2) to investigate whether phonological awareness and morphological awareness contribute to phonetic radical and semantic radical awareness, respectively, and (3) to determine whether the relationship between metalinguistic awareness (i.e., phonological awareness and morphological awareness) and different aspects of Chinese reading (i.e., single-character and two-character reading), if observed, is mediated by radical awareness (i.e., phonetic radical awareness and semantic radical awareness) under the premise that metalinguistic awareness affects radical awareness.

Predictions

Recall that the creation of most two-character words in Chinese is governed by morphological rules. For this reason, morphological awareness was anticipated to greatly contribute to two-character reading. By contrast, no morphological context is available in single-character reading; therefore, the contribution of morphological awareness to single character reading should be at best trivial if not nonexistent. In addition, morphological

awareness was expected to contribute to semantic radical awareness given the common component (i.e., semantic processing) that is shared by the two types of awareness. Furthermore, morphological awareness should affect Chinese reading through its impact on semantic radical awareness.

Phonological awareness, which only taps phonology but not morphology of a spoken word, should play a minor role in two-character reading, which should instead rely more on morphological analysis (Liu et al., 2010). Conversely, phonological awareness should play an important role in single-character reading, as has been found in previous studies. In addition, phonological awareness was expected to contribute to phonetic radical awareness because it helps children appreciate the phonological similarity between a character and its phonetic radical. Furthermore, the hypothesized relationship between phonological awareness and Chinese reading should be mediated by phonetic radical awareness.

Chapter IV: Methods

In the present study, third grade Mandarin-speaking children in Taiwan were recruited as the participants. These children had received two years of formal reading instruction, which should provide them with the radical knowledge necessary to complete the radical awareness tests. Specifically, they were administered the measures of phonological awareness (i.e., onset-rime awareness) and two types of morphological awareness (i.e., homophone awareness and morphological construction), along with the measures of two types of radical awareness (i.e., phonetic radical awareness and semantic radical awareness) and vocabulary knowledge. They were then given a single-character reading task and a two-character reading task.

Participants

A total of 109 Chinese third graders (61 males and 48 females) recruited from nine classes in two predominately middle-class elementary schools in New Taipei City, Taiwan (five classes from an elementary school in Zonghe District and four classes from an elementary school in Banqiao District) served as the participants. The children were assessed in February of the spring semester in 2013. The average age of these children when tested was 110.61 months, with a range of 103.93 months to 116.97 months. All of the children spoke Mandarin Chinese as the main language of daily conversation with their teachers and classmates at school. Prior to the present study, both parents' informed written consents and children's oral assents were obtained. Based on the teachers' report, children who displayed a history of learning disability, language impairment, articulatory disorder, or neurological, emotional and sensory deficits were excluded from the present study.

All of the participants were receiving reading instructions typical for Taiwanese children. In Taiwan, children receive 10 weeks of instructions in the Mandarin Phonetic Alphabets, *Zhuyin*

Fuhao, at the very beginning of elementary school. After the 10-week *Zhuyin Fuhao* instruction, children begin to learn to read and write Chinese characters accompanied by *Zhuyin Fuaho* until grade 4, after which *Zhuyin Fuhao* is taken away from learned characters and is only printed alongside new characters to be learned. Two major goals of the *Zhuyin Fuhao* instruction are (1) to help children read new characters, and (2) to enable children to write characters when presented with their corresponding *Zhuyin Fuhao* and vice versa. In addition to the *Zhuyin Fuhao* instruction, basic orthographic knowledge about phonetic radicals and semantic radicals is also introduced to children in the Chinese textbooks. For example, the semantic radical (e.g., 扌 'hand-related') of a character (e.g., 捉 'catch') is highlighted in color, and the exemplar characters containing the same semantic radical (e.g., 抱 'carry', 搖 'shake', 打 'hit', 摸 'touch', etc.) are also provided. As for phonetic radicals, a list of characters containing the same phonetic radical (e.g., 請 /qing3/, 情/qing2/, 晴 /qing1/, 靜 /jing4/, etc.) is given under that phonetic radical (e.g., 青 'qing1'). According to the curriculum guidelines by the Minister of Education in Taiwan, by the end of the third grade, children are expected to recognize at least 800 characters. Another important focus of the Chinese textbooks is the distinction of homophones, which is taught by presenting words containing a certain homophone in a sentence. From the sentential context, children can easily distinguish the meanings of homophones. For example, the two homophones 哥 /ge1/ 'elder brother' and 歌 /ge1/ 'song' are presented in two words, 哥哥 /ge1ge1/ 'elder brother' and 唱歌 /chang4ge1/ 'sing songs', within the following sentence.

哥哥	喜歡	唱歌.
/ge1ge1/	/xi3huan1/	/chang4ge1/
elder brother	like	sing songs

'Elder brother likes singing songs'.

Compared to the distinction of homophones, word formation is much less emphasized in the

Chinese textbooks used in Taiwan. One approach to word formation employed in the Chinese textbooks is to present one morpheme (e.g., 訊 /xün4/ 'information') followed by the words composed of that morpheme (e.g., 訊問 /xü4wen4/ 'interrogate', 訊號 /xün4hao4/ 'signal', 通訊 /tong1xün4/ 'communication', 訊息 /xün4xi2/ 'message', etc.). Children are then instructed that words containing the same morpheme are usually semantically related.

Tasks and Procedures

Participants were administered a battery of tasks: one phonological awareness task, two morphological awareness tasks, two radical awareness tasks, two reading tasks and one vocabulary knowledge task. The vocabulary knowledge task was administered to control for vocabulary development on metalinguistic awareness and reading performance. Children's phonological awareness was assessed with an onset-rime awareness task, which measured their sensitivity to the phonological structure of spoken syllables at the onset-rime level. Children's morphological awareness was assessed with a homophone awareness task, which measured their ability to distinguish the meanings of different spoken homophones, and a morphological construction task, which measured their ability to apply morphological rules to create novel words. Children's radical awareness was assessed with a phonetic radical awareness task, which measured their ability to read characters based on their phonetic radicals; and a semantic radical awareness task, which measured their ability to identify a character based on its semantic radical. The two reading tasks were a single-character reading task, which assessed their ability to read mono-morphemic words, and a two-character reading task, which measured their ability to read bi-morphemic words.

Given that the onset-awareness task, homophone awareness task, phonetic radical awareness task, semantic radical awareness task and two-character reading task were newly

created for the purpose of the present study, a pilot study was conducted to evaluate their appropriateness for third-graders in Taiwan. An item analysis was run for each of the tasks to select the items that best distinguished good from poor performers. The results of the pilot study showed that these tasks all had an acceptable to excellent internal consistency (Cronbach's Alpha). The detailed description of the pilot study is in Appendix A.

The children were individually administered all of the tasks at one time in a quiet room for an average of 40-50 minutes. Their audio responses were audio-recorded for post-scoring and later analysis. The order of task administration was onset-rime awareness task, homophone awareness task, semantic radical awareness task, phonetic radical awareness task, morphological construction task, single-character reading task, two-character reading task and vocabulary knowledge task. The details of each task are described below.

Onset-rime Awareness Task

In this study, children's phonological awareness was measured at the onset-rime level but not at the syllable level because onset-rime awareness was found in previous studies (e.g., Newman, Tardif, Huang, & Shu, 2011) to better predict elementary school children's reading ability than syllable awareness. The onset-rime awareness task was administered in an "oddity" format, where the child was required to identify out of three spoken syllables the "odd" one that had a different onset or rime from the other two syllables. There were 11 test trials in this task (*see* Appendix B for the test stimuli): six onset trials (e.g., /la1/, /hei1/, /he1/) and five rime trials (e.g., /ti1/, /zhao1/, /pi1/). Hu and Catts (1998) found that the trial containing three syllables with different tones (e.g., /po**2**/, /da**4**/, /ma**3**/) in the onset-rime awareness task posed great difficulty for children. Given this finding, the trial with different tonal syllables may not purely measure children's onset-rime awareness independent of the effect of tones. To avoid this potential

confound caused by different tones, all of the syllables in a triad were assigned the same tone in this task. The three syllables were presented as a set twice to the children, accompanied by three printed numbers, 1, 2 and 3, respectively, on the answer sheet. The positions of the correct answers were counterbalanced across the 11 trials. The children had to pay special attention to the beginning or ending sounds of the three spoken words depending on the trial type (i.e., onset or rime trial). The children's job was to circle the number representing the spoken word that had a different beginning or ending sound.

Three practice trials were given before the test trials to make sure that the children understood the task. The feedback on the correctness of the response was given to the children in the practice trials. If the children made an error in the practice trial, they were given the correct answer and told why it was correct. During the test trials, no feedback was provided to the children, and they were asked to try their best to complete the task on their own. One point was given for each correct response (max = 11). The internal consistency (Cronbach's Alpha) of this task obtained in the pilot study was .84. The instructions for this task are given below:

> "I am going to read three spoken words for you, and you will see three numbers, 1, 2 and 3 here on this sheet. The three numbers represent the three spoken words I just read. One spoken word has a different beginning/ending sound from the other two. Please listen carefully to the beginning/ending sounds of each word and circle the number representing the spoken word that has a different beginning/ending sound. Now, listen! /la1/, /hei1/, /he1/ (pointing to the numbers 1, 2, and 3, respectively). One of the spoken words has a different beginning sound from the other two. Can you tell me which one? Is it /la1/, /hei1/, or /he1/ (pointing to the numbers 1, 2, and 3, respectively)? Please circle the number for me!"

Homophone Awareness Task

In this task, the children compared and distinguished homophones embedded in familiar spoken words. Like the onset-rime awareness task, the homophone awareness task was also administered in the "oddity" format. There were a total of 11 trials in this task (*see* Appendix C for the test stimuli). On each trial, the children were orally presented with three familiar bimorphemic words, all of which shared a homophone. Given that Chinese homophones are more easily distinguished in the print form (i.e., characters) than in the oral form, the children may make use of their character knowledge to discriminate the spoken homophones (Hu, 2013). To avoid this possibility, the homophones to be compared in this task were carefully selected so that their corresponding characters were unknown to most third graders in Taiwan based on three school teachers' judgment. This would ensure that the children judged the meanings of the spoken homophone solely based on their oral language experience rather than their print experience. In each trial, two words shared a semantically similar homophone, which was not shared by the third word (i.e., the odd word). The three words were presented as a set twice to the children, accompanied by three printed numbers, 1, 2 and 3, respectively, on the answer sheet. The children were required to circle the number representing the odd word from the three words. The positions of the odd words were counterbalanced across the 11 test trials.

In this task, two types of trials were included. In the first type (five trials), the position of the homophone of the odd word is the same as those of the homophones of the other two words, such as 裝**飾** /zhuang1**shi4**/ 'decorate', 解**釋** /jie3**shi4**/ 'explain' and 修**飾** /xiu1**shi4**/ 'modify'. In the second type (six trials), the position of the homophone of the odd word was different from that of the homophone(s) of either or both of the other two words, such as 彎**腰** /wan1**yao1**/ 'bend', **邀**請 /**yao1**qing3/ 'invite' and 受**邀** /shou4**yao1**/ 'being invited'.

The test trials were preceded by three practice trials, during which the experimenter explained to the children how to do this task and provided feedback on the correctness of the response when necessary. There was no feedback given on the test trials. One point was given for each correct response (max = 11). The internal consistency (Cronbach's Alpha) of this task obtained in the pilot study was .76. The instructions used for this task are given below:

> "I am going to read three spoken words for you, and you will see three numbers, 1, 2 and 3 here on this sheet. The three numbers represent the spoken words I just read. The three words share a homophone. The meaning of one homophone was different from those of the other two. I want you to listen carefully to the three spoken words, and circle the number representing the word that contained a semantically different homophone. Now, listen! 公雞 /gong1ji1/ 'rooster', 小雞 /xiao3ji1/ 'chick' and 飛機 /fei1ji1/ 'airplane' (pointing to the numbers 1, 2, and 3, respectively) all have /ji1/. Which word do you think contains /ji1/ that has a different meaning from the other two? Is it 公雞 /gong1ji1/ 'rooster', 小雞 /xiao3ji1/ 'chick' or 飛機 /fei1ji1/ 'airplane' (pointing to the numbers 1, 2, and 3, respectively)? Please circle the number for me!"

Semantic Radical Awareness Task

The format of the semantic radical awareness task was similar to that adopted in Shu and Anderson's (1997) study except for the way to present the test stimuli (see below). There were a total of 10 trials in this task (*see* Appendix D for the test stimuli). For each trial, the children were orally provided with a familiar spoken word (e.g., 瞳孔 /tong2kong3/ 'pupil'). One constituent morpheme of the spoken word (e.g., 瞳 /tong2/) was unknown in print to the child based on three school teachers' judgment and served as the target morpheme. The semantic radical of the character representing the target morpheme contributed to the meaning of that

morpheme (i.e., transparent semantic radical). Since the children were expected to select the character based on its semantic radical, the character with an opaque semantic radical (which provided no semantic cues) was not used in this task. Followed by the oral presentation of the spoken word was the visual presentation of three unknown printed characters (e.g., 僮, 瞳, 潼), one of which represented the target morpheme. The three characters shared the same phonetic radical (e.g., 童 /tong2/) and thus were pronounced the same, but had a different semantic radical (e.g., 目 in 瞳, 月 in 膧, and 氵 in 潼). The semantic radical (e.g., 目 'eye-related') of the character representing the target morpheme (e.g., 瞳) specified the semantic category of the spoken word (e.g., 瞳孔 /tong2kong3/ 'pupil'). The semantic radicals of the other two characters (e.g., 僮 and 潼) denoted different semantic categories (e.g., 亻 is 'human-related'; 氵 is 'water-related') from the semantic radical of the character representing the target morpheme. The children were required to circle the character from the three printed characters that represented the target morpheme. The positions of the correct answers were counterbalanced across the 10 trials. A comparable English example would be to orally present a phrase (e.g., *one cent*) to the children, followed by the visual presentation of three printed words (e.g., *cent*, *sent* and *scent*) and ask the children to circle the correct printed word to represent the target word in the phrase.

The procedure used in the present study (i.e., oral presentation) was different from that in Shu and Anderson's (1997) study, where the test words were presented in print. In their study, the character of the target morpheme was represented by its *Pinyin* (i.e., the phonetic alphabet used in China), and the children were asked to select an appropriate character to replace the *Pinyin*. The present study did not visually present the test words and did not use *Zhuyin Fuhao* to represent the character of the target morpheme because the individual differences in decoding

Zhuyin Fuhao may confound the results.

For this task, item difficulty was manipulated by including words varying in conceptual abstractness. A simple trial consisted of a concrete word that is easier to illustrate with pictures (e.g., 瞳孔 /tong2kong3/ 'pupil'), whereas a more difficult trial consisted of an abstract word that is harder to depict with pictures (e.g., 謠言 /yao2yan2/ 'rumor'). There were six simple trials and four difficult trials in this task. The test trials were preceded by three practice trials, where the experimenter made sure that the children understood the task. One point was given for each correct response to the test trial (max = 10). The internal consistency (Cronbach's Alpha) of this task obtained from the pilot study was .73. The instructions for this task are given below:

> "I am going to read a word for you, and you will see three printed characters on this sheet. One of the three printed characters represents a constituent sound of the word I just read, and I want you to circle that character for me. Now, listen! Which of the three printed characters represents 狗 /gou3/ 'dog' in 小狗 /xiao3gou3/ 'puppy'? Please circle the character for me!"

Phonetic Radical Awareness Task

The phonetic radical awareness task was similar to that used by Ho, Ng and Ng (2003). In this task, the children were required to read 16 pseudo-phonograms (*see* Appendix E for the test stimuli). A pseudo-phonogram was created by combining a phonetic radical (e.g., 馬 /ma3/) and a semantic radical (e.g., 言) in their legal positions, but the combination (e.g., 誗 /ma3/) did not comprise a real character in Chinese. The only cue to the pronunciation of the pseudo-phonogram was through its phonetic radical. According to Ho, Ng and Ng (2003), the pseudo-phonogram reading task can be employed to measure children's overall knowledge of the function and sound value of the phonetic radical, and their ability to use direct derivation and

analogy strategies to pronounce a novel character.

Two types of phonetic radicals were selected to make the pseudo-phonograms for this task: one type was the free phonetic radical, which can stand alone as a real character; the other type was the bound phonetic radical, which cannot appear alone as a real character but must be attached to a semantic radical. The free phonetic radical directly provided the pronunciation of a pseudo-phonogram that contains it (e.g., 𧵑 /ma3/ shown above). On the other hand, a pseudo-phonogram with a bound phonetic radical must be pronounced by analogy with other characters containing the same bound phonetic radical. For example, the pseudo-phonogram 鄜 /fu4/ shares the same bound phonetic radical, 畐, with real characters, such as 副 /fu4/.

For this task, item difficulty was manipulated by including phonetic radicals with various frequencies at which they occur in different Chinese characters. Zhou's (1980) book, *Phonological Information of the Phonetic Radical of Character Consultant*, served as the basis for choosing the phonetic radical. A simple trial consisted of a pseudo-phonogram whose phonetic radical (e.g., 馬) can be used to generate eight or more characters. A more difficult trial consisted of a pseudo-phonogram whose phonetic radical can be used to generate five or less real characters (e.g., 受). The boundness and frequency of the phonetic radical crossed orthogonally with each other, yielding four types of stimuli: free/high frequent (4 trials), free/low frequent (5 trials), bound/high frequency (4 trials), and bound/low frequency (3 trials). One point was given for each correct response (max = 16). The internal consistency (Cronbach's Alpha) of this task obtained from the pilot study was .89. The instructions for this task are given below:

> "Here are some funny characters that you have never seen before. They are all readable. Now, I want you to try your best to read each character for me. If you don't know how to read a character, just skip it. I cannot help you!"

Morphological Construction Task

This task was borrowed from Hu's (2013) study. According to Chen et al. (2008), the completion of the morphological construction task requires two main abilities: the ability to analyze a spoken word into its consistent morphemes and the ability to create novel words with the already-analyzed morphemes. In this task, the children produced novel words based on the scenarios orally given by the experimenter. There were a total of 20 trials in this task, where the children were prompted to produce novel words through compounding (10 trials), derivation (6 trials) and reduplication (4 trials) (*see* Appendix F for the test stimuli). For example, in the case of compounding, the child was told "The 公車 /gong1che1/ 'buses' that are 經營/jing1ying2/ 'run' by 台北市/tai2bei2-shi4/ 'Taipei City' are called 市營公車/shi4-ying2 gong1xhe1/ 'city-run buses'. If your 學校 /xue2xiao4/ 'school' also wants to run 公車 /gong1che1/ 'buses', what would you call them?" The answer was 校營公車 /xiao4-ying2 gong1che1/ 'school-run buses'. One example of derivation was "When we want to have more 綠 /lü4/ 'green' plants in our environment, we say we will 綠化 /lü4-hua4/ 'green-ify' our environment. If we want to have more 香 /xiang1/ 'fragrance' in our environment, what we say we do to our environment?" The answer was 香化/xiang1-hua4/ 'fragrant-ify'. The suffix 化 /–hua4/ in Chinese functions as a derivational morpheme which converts an adjective into a verb.

Before the test trials, the children were provided with four practice trials, which required them to say a real word based on a scenario orally given by the experimenter that described another real word. If the children gave a wrong answer in response to the given scenario, the experimenter corrected them and explained how the answer was derived from the given scenario. For the test trials, no feedback was provided, and one point was given for each correct response (max = 20). The internal consistency of this task was .89. The four practice trials were integrated

into the instructions for this task, as shown below:

"Listen! If a friend comes from 美國 /mei3guo2/ 'the USA', we call him 美國人 /mei3guo2-ren2/ 'American'. If he comes from 英國 /ying1guo2/ 'England', we call him 英國人 /ying1guo2-ren2/ 'British'. If he comes from 印度 /yin4du4/ 'India', what would you call him? (the answer is 印度人 /yin4du4-ren2/ 'Indian') If he comes from 肯亞 /ken3ya4/ 'Kenya', what would you call him? (the answer is 肯亞人 /ken3ya4-ren2/ 'Kenyan')"

"Now listen! A person who has the greatest power in a 學校 /xue2xiao4/ 'school' is called 校長 /xiao4zhang3/ 'principal'. A person who has the greatest power in a 班級 */ban1ji2/* 'class' is called 班長 /ban1zhang3/ 'class leader'. What would you call a person who has the greatest power in a 商店 /shang1dian4/ 'store'? (the answer is 店長 /dian4zhang3/ 'boss') What would you call a person who has the greatest power in a 城市 /zheng2shi4/ 'city'? (the answer is 市長 /shi4zhang3/ 'mayor')"

"Good job! You know how to create a new word following the way I used. Now, I am going to give you more scenarios. I want you to listen carefully to these scenarios and create some novel words for me using the way you just learned in the previous examples."

Single-character Reading Task

A standardized test, *Graded Chinese Character Recognition Test* (Huang, 2004), was employed to measure children's ability to read single characters. This test was developed based on two ideas: (1) poor readers and good readers can be successfully distinguished by their abilities to read words out of context (Stanovich, 1986), and (2) children's performance in a

single-character reading test usually serves as an index for general reading ability (McBride-Chang & Ho, 2000). This character reading test is designed for first to sixth graders of elementary schools and seventh to ninth graders of junior high schools in Taiwan. The test included 10 difficulty levels of characters selected from the *Corpus-Based Frequency Count of Words in Journal Chinese* (Chinese Knowledge Information Processing Group, 1993). There are 20 characters at each level, yielding a total of 200 characters. The average frequency of occurrence and the average number of strokes of the 200 characters are 3541.94 and 12.53, respectively. Around 55.5% of the 200 characters appear in the elementary school textbooks in Taiwan.

The 200 characters were displayed in 20 rows of 10 items each on two sheets of A4 size paper, with 100 characters each. The first 40 characters were printed in the Baiu Font 32, and the remaining 160 characters the Baiu Font 30. The characters were arranged in descending order of frequency of occurrence. The children were required to read each character one by one until 20 consecutive errors were made. The purpose of the 20-error stop criterion, as reported in the test manual, is to avoid any possible confound caused by the children's guessing behaviors. One point was given for each correctly-read character (max = 200). The internal consistency of this test is .99 and the test-retest reliabilities are from .81 to .95. The instructions for this task are given below:

> "Here are some characters, and I want to know how many characters you can read. Please start to read the characters one by one from here until I ask you to stop."

Two-character Reading Task

Because there is no standardized two-character reading test in Taiwan, a new two-character test was invented for the present study. In this test, the children read 43 two-character words

selected from the Chinese textbooks of grade 1 to grade 6 (*see* Appendix G for the test stimuli). The test words were all composed of two morphemes. In Chinese, most morphemes correspond to one syllable and one character, such as 貓 /mao1/ 'cat'; however, Chinese has a few disyllabic morphemes which are represented by two characters, such as 葡萄 /pu2tao2/ 'grape'. Given that the present study was to see whether morphological construction (which involved the decomposition of words into constituent morphemes and the insight into the morphological structure in words) would help children analyze the internal structure of a bimorphemic word in reading, two-character words that were composed of only one disyllabic morpheme (which cannot be further analyzed into constituent morphemes) were excluded in this task. The average frequency of occurrence for the 43 two-characters was 14.40 (Range = 1 - 64) based on the *Technical Report of the Word Frequencies of Occurrence in the Chinese Dictionary* published by the Ministry of Education (1997) in Taiwan.

The 43 two-character words were printed in Kaiu Font 30 on a sheet of A4 size paper. These words were displayed in four rows of ten items each and one row of three items and were arranged from high to low frequency of occurrence. The children were required to read all of the 43 words one by one. One point was given for each two-character word correctly read (max = 43). The internal consistency (Cronbach's Alpha) of this task obtained in the pilot study was .96. The instructions for this task are given below:

> "Here are some two-character words, and I want to know how many words you know. Please start to read the words one by one from the first word until you finish reading all of the words. If you don't know how to read a word, just skip it. I cannot help you."

Vocabulary Knowledge Task

The Chinese version of Peabody Picture Vocabulary Test (Lu & Liu, 1998) was employed to

measure children's vocabulary knowledge. This test is a standardized norm-referenced vocabulary test developed specifically for Taiwanese children aged 3 to 16 years old. It has two alternative forms (Form A and Form B), each of which contains 125 test words arranged in ascending order of difficulty. Each test word is accompanied by a four-picture plate. The 125 test words fall into 19 categories, such as action, animal, clothing, food, body part, mathematical term, geographic term, adjectives, to name a few.

In this test, the children were presented with a four-picture plate, from which they were required to choose the one that best fit the meaning of an orally presented word. Two practice trials were given before the test trials to make sure that the children had met the minimum criterion of taking this test. If the children failed in the two practice trials, they would not be given this test. One point was given for each correct response. The child was tested from a basal of eight consecutive correct responses to a ceiling of six errors in eight consecutive test words. The children's raw score was calculated by subtracting the number of errors from the number of words attempted before the ceiling was reached (max = 125). The test manual specifies that the internal consistency is from .90 to .97, and the alternative form reliability is .79. The instructions for this task are given below:

> "I am going to show four pictures to you, and I will say a word. One of the four pictures represents the word I just said. Please look at the pictures carefully and select the picture you think that best represents the word I just said."

Chapter V: Results

To answer the research questions on the relative roles of phonological awareness and morphological awareness in Chinese reading, multiple regression analyses and path analyses were applied to Chinese third graders in Taiwan. The regression analysis was adopted to examine the unique contributions of phonological awareness and morphological awareness to Chinese reading, and the path analysis was employed to explore the relative associations of phonological awareness and morphological awareness with Chinese reading. The same analysis methods were subsequently employed to test the potential mediating effect of phonetic radical awareness and semantic radical awareness on the relationship between the two types of metalinguistic awareness and Chinese reading.

Performance on the Study Measures

Descriptive statistics for all of the tasks administered as well as the correlations among these tasks are first reported to provide a general picture of children's performance on each task. Table 3 presents the descriptive statistics of children's age and performance on each task. All of the scores are presented as raw scores.

Table 3

Descriptive statistics for the tasks administered

	Total score	Mean	SD	% Correct	Min	Max	Skewness
Age		110.61	3.54		103.93	116.97	-0.11
VOC	125	97.00	9.23	77.60	67.00	116.00	-0.91
Onset-rime_A	11	7.54	2.36	68.55	1.00	11.00	-0.34
Homophone_A	11	7.04	1.94	64.00	2.00	11.00	-0.26
Semantic_A	10	8.21	1.24	82.10	5.00	10.00	-0.41
Phonetic_A	16	10.73	3.18	67.06	2.00	16.00	-0.53
Morphological_C	20	9.94	4.39	49.70	0.00	20.00	0.01
Single_character_R	200	104.86	21.76	52.43	50.00	162.00	-0.03
Two_character_R	43	22.56	9.36	52.46	1.00	42.00	-0.38

Note. VOC = vocabulary; Onset-rime_A = onset-rime awareness; Homophone_A = homophone awareness; Semantic_A = semantic radical awareness; Phonetic_A = phonetic radical awareness; Morphological_C = morphological construction; Single_character_R = single-character reading; Two_character_R = two-character reading

To examine whether there were ceiling or floor effects on the tasks, the skewness of each task was inspected. As shown in Table 3, there was no obvious sign of floor or ceiling effects on almost all of the tasks, skewness = -0.53~0.01, indicating that they were nearly normally distributed. The vocabulary test was the exception, skewness = -.91, suggesting a ceiling effect on vocabulary knowledge.

Onset-Rime Awareness

On the onset-rime awareness task, the mean number of correct responses was 7.54 (out of 11). Previous research has shown that Chinese children's experience with Chinese phonetic alphabets (e.g., *Zhuyin Fuhao*) benefit their development of phonological awareness because the alphabets make the sound structure of a spoken word visually accessible. In the present study, the children had received 2.5 years of instructions in *Zhuyin Fuhao* before being tested on phonological awareness. One possible consequence is that their phonological awareness may be

at ceiling on the present task. However, the children's performance on the onset-rime awareness task did not evidence a ceiling effect, skewness = -.34, indicating that this task could efficiently distinguish better phonological awareness from poorer phonological awareness.

Homophone Awareness

On the homophone awareness task, the mean number of correct responses was 7.04 (out of 11). Recall that the homophones to be compared were carefully selected such that their corresponding characters were unknown to most third graders in Taiwan based on three teachers' judgments. In this case, the children were expected to distinguish the homophones based merely on their oral language experience but not on their extant character knowledge. If the children had learned all of the characters representing the homophones to be assessed, their performance on this homophone awareness task would have reached its ceiling. The skewness of this task was -.26, evidencing no ceiling effect and thus confirming the success in selecting the homophones in this task.

Semantic Radical Awareness

On this task, children scored a mean of 8.21 (out of 10). Recall that the three alternative characters selected for the semantic radical awareness task were designed to be unfamiliar to the children of the present study so that they had to infer the meanings of the unknown characters based solely on their semantic radicals. If the children had learned the characters used in this task, their performance should have reached its ceiling. However, no ceiling effect was found on this task, skewness = -.41, suggesting the success in stimulus selection in this task.

Phonetic Radical Awareness

On this task, the children correctly read an average of 10.73 (out of 16) pseudo-phonograms. To assure that there was enough variability in performance on this task, the difficulties of the

phonetic radicals were manipulated by varying the frequencies at which they appear in real characters. The skewness of this task was -.53, indicating no ceiling effect and thus suggesting the efficiency of stimulus manipulation based on the frequency data.

Morphological Construction

On this task, the mean number of correct responses was 9.94 (out of 20), with a percent correct of 49.70. This result was a little higher to that found in Hu's (2013) study, from which the morphological construction task was borrowed for the present study. In her study, Chinese third graders in Taiwan had a percent correct of 43.79 on the same morphological construction task. The small difference in the percent correct may just reflect a maturation effect, i.e., the children of the present study were 6 months older than those in Hu's study (children's age = 110.61 months in the present study and 104.77 months in Hu's study). The task had a skewness index of .01, indicating no ceiling or floor effect; thus, this task successfully discriminated children with various degrees of morphological construction.

Single-Character Reading

On this task, the children could read an average of 104.86 (out of 200) single characters. A closer look at the children's errors in this task shed some light on the processes the children might go through when reading single characters. For example, many children tended to rely on the phonetic radical to read an unfamiliar character, resulting in a regularization error. This type of error has been widely observed in Chinese children (e.g., Huang, 2000). In addition, some episodic cases revealed that the access to a word containing the target character to be read could help the children in reading unfamiliar characters. The access-to-word strategy did not always lead to erroneous readings of characters; rather, it could sometimes help children retrieve the correct pronunciation of an unfamiliar character. Finally, reading a character based on

orthographic similarity between target characters and other characters was another strategy the children used on this task.

Two-Character Reading

On this task, the children could read an average of 22.56 two-character words (out of 43). Several error types could be observed on this task. Like the reading of single characters, many children made use of phonetic radicals to read the unknown character of the two-character words. For example, some children read 警惕 /jing3ti4/ as /jing3yi4/, where /yi4/ was the pronunciation of 易, the phonetic radical of the unknown character 惕 /ti4/. Other children relied on orthographic similarity to read on this task. For example, when reading the unknown character, 持 /chi2/ of the two-character word 僵持 /jiang1chi2/, some children read it as an orthographically similar character 特 /te4/. Still other children wrongly read a two-character word as another two-character word that retained one morpheme of the target two-character word, such as reading 技藝 /ji4yi4/ 'artistry' as 技術 /ji4shu4/ 'technique', both of which shared the same morpheme 技 /ji4/ 'skill'. In Chinese, words sharing a morpheme are usually semantically related; therefore, semantics might play a role in reading two-character words.

Relationships among the Study Measures

For the purposes of the present study, regression analyses and path analyses were adopted. A path analysis is designed to make causal inference from correlational data. Pearson product-moment correlation coefficients were calculated to make sure there were potential causal relationships among the variables of interest. The correlation matrix was presented in Table 4.

Table 4.

Intercorrelations among variables

	Age	Onset-rime_A	Homophone_A	Morphological_C	Phonetic_A	Semantic_A	Single_character_R	Two_character_R	VOC
Age									
Onset-rime_A	.12								
Homophone_A	.09	.10							
Morphological_C	.16	.24*	.34***						
Phonetic_A	.15	.21*	.15	.35***					
Semantic_A	.07	.17	.28*	.31**	.18				
Single_character_R	.04	.22*	.48***	.53***	.47***	.43***			
Two_character_R	.04	.19*	.54***	.48***	.28**	.56***	.82***		
VOC	.06	.12	.47***	.48***	.17	.51***	.59***	.69***	

Note. VOC = vocabulary; Onset-rime_A = onset-rime awareness; Homophone_A = homophone awareness; Semantic_A = semantic radical awareness; Phonetic_A = phonetic radical awareness; Morphological_C = morphological construction; Single_character_R = single-character reading; Two_character_R = two-character reading

* $p < .05$

** $p < .01$

*** $p < .001$

All of the six paired-wise correlations between the Chinese reading measures (single-character and two-character reading) and the metalinguistic awareness measures (onset-rime awareness, homophone awareness and morphological awareness) were significant, with r = .19 to .54, all ps < .05. Note that homophone awareness and morphological awareness were only moderately correlated, r = .34, p < .01; thus, the two morphological awareness measures will be analyzed separately in the following analyses.

In order to examine the relative strengths of the six paired-wise correlations before the control variables (i.e., vocabulary knowledge and age) were considered in the regression analyses and path analyses, Fisher's z-tests for comparing two dependent correlations were conducted. For each of the two reading measures, the correlation coefficient for phonological awareness was compared to those for the two morphological awareness measures. The results showed that single-character reading was more strongly correlated with either morphological awareness measure than with the onset-rime awareness measure, z = 2.23, p < .05 for homophone awareness vs. onset-rime awareness and z = 2.95, p < .01 for morphological construction vs. onset-rime awareness. The same pattern of associations was obtained for two-character reading. Two-character reading was more strongly correlated with either morphological awareness measure than with the onset-rime awareness measure, z = 3.07, p < .01 for homophone awareness vs. onset-rime awareness and z = 2.68, p < .01 for morphological construction vs. onset-rime awareness. These results suggested that morphological awareness appeared to be a more critical factor than phonological awareness in determining individual reading abilities of Chinese children. In terms of the two morphological awareness measures, homophone awareness was related equally to single-character reading and to two-character reading, z = 1.22, p > .05, as was morphological construction, z = 1.01, p > .05, indicating that

the two morphological awareness measures were equally important in single-character and two-character reading in Chinese.

Recall that radical awareness was specified as the mediator of the relationship between metalinguistic awareness and Chinese reading; therefore, it is important that radical awareness be related to both metalinguistic awareness and Chinese reading. As expected, onset-rime awareness was related to phonetic radical awareness, $r = .21$, $p < .05$, while homophone awareness and morphological construction were both related to semantic radical awareness, $r = .28$, $p < .05$ for homophone awareness and $r = .31$, $p < .01$ for morphological construction. Phonetic radical awareness was related to single-character reading, $r = .47$, $p < .001$, and two-character reading, $r = .28$, $p < .01$, which were both related to semantic radial awareness, $r = .43$, $p < .001$ for single-character reading and $r = .56$, $p < .001$ for two-character reading. A further comparison of the two dependent correlations using Fisher's *z*-test showed that phonetic radical awareness was more strongly correlated with single-character reading than with two-character reading, $z = 3.60$, $p < .001$, while semantic radical awareness was more strongly correlated with two-character reading than with single-character reading, $z = 2.64$, $p < .01$.

Unique Contributions of Metalinguistic Awareness to Chinese Reading

To address the first purpose of the present study, a series of hierarchical multiple regressions were conducted to explore the relative contributions of phonological awareness and morphological awareness separately to single-character reading and to two-character reading. In these analyses, children's age and vocabulary knowledge were entered first to control for the effect of the two variables. Onset-rime awareness and homophone awareness/morphological construction were entered as predictors at the last two steps to examine their unique contributions to Chinese reading. Tables 5-8 show the results of the regression analyses.

Table 5.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by homophone awareness with age, vocabulary knowledge and onset-rime awareness controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Onset-rime_A	.38	.03*	.49	.01
3	Homophone_A	.43	.05**	.54	.06***

Note. Onset-rime_A = onset-rime awareness; Homophone_A = homophone awareness;

* $p < .05$

** $p < .01$

*** $p < .001$

Table 6.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by morphological construction with age, vocabulary knowledge and onset-rime awareness controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Onset-rime_A	.38	.03*	.49	.01
3	Morphological_C	.44	.07**	.51	.03*

Note. Onset-rime_A = onset-rime awareness; Morphological_C = morphological construction;

* $p < .05$

** $p < .01$

*** $p < .001$

Table 7.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by onset-rime awareness with age, vocabulary knowledge and homophone awareness controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Homophone_A	.41	.06**	.53	.06***
3	Onset-rime_A	.43	.02	.54	.01

Note. Onset-rime_A = onset-rime awareness; Homophone_A = homophone awareness;
** $p < .01$
*** $p < .001$

Table 8.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by onset-rime awareness with age, vocabulary knowledge and morphological construction controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Morphological_C	.43	.08***	.50	.03*
3	Onset-rime_A	.44	.01	.51	.01

Note. Onset-rime_A = onset-rime awareness; Morphological_C = morphological construction;
* $p < .05$
*** $p < .001$

It was found that when entered at the last step, homophone awareness accounted for 5% of unique variance in single-character reading and 6% of unique variance in two-character reading

(Table 5), while morphological construction accounted for 7% of unique variance in single-character reading and 3% of unique variance in two-character reading (Table 6). In contrast, onset-rime awareness did not account for any additional variance in the two aspects of Chinese reading over and above the effect of homophone awareness/morphological construction and the control variables (Tables 7 & 8), suggesting that phonological awareness was not as important as morphological awareness in predicting Chinese reading. In addition, homophone awareness seemed to contribute more to two-character reading than to single-character reading, while the opposite pattern was observed for morphological construction, which contributed more to single-character reading than to two-character reading.

Mediation of Radical Awareness in the Relationship between Metalinguistic Awareness and Chinese Reading

A primary focus of the present study was to examine whether metalinguistic awareness exerts its influence on Chinese reading through its effect on radical awareness. As shown previously in the correlation analyses, radical awareness was related to both metalinguistic awareness and Chinese reading, suggesting a possible mediation by radical awareness of the relationship between metalinguistic awareness and Chinese reading. To test this potential mediating effect, multiple regression analyses were used. If radical awareness mediated the relationship between metalinguistic awareness and Chinese reading, metalinguistic awareness should not explain any variance in Chinese reading after the variance in radical awareness has been partialled out. A series of hierarchical regression analyses were carried out to test (1) the mediation of phonetic radical awareness between onset-rime awareness and two aspects of Chinese reading, and (2) the mediation of semantic radical awareness between homophone awareness/morphological construction and two aspects of Chinese reading. Tables 9-11 present

the results of the regression analyses.

Table 9.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by onset-rime awareness with phonetic radical awareness, age and vocabulary knowledge controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Phonetic_A	.49	.14***	.50	.03*
3	Onset-rime_A	.50	.01	.51	.01

Note. Onset-rime_A = onset-rime awareness; Phonetic_A = phonetic radical awareness;

* $p < .05$

*** $p < .001$

Table 10.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by homophone awareness with age, vocabulary knowledge and semantic radical awareness controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Semantic_A	.37	.02	.53	.06***
3	Homophone_A	.42	.05**	.59	.06***

Note. Homophone_A = homophone awareness; Semantic_A = semantic radical awareness;

** $p < .01$

*** $p < .001$

Table 11.

Unique variance (R^2 change) in single-character reading and two-character reading accounted for by homophone awareness and morphological construction with semantic radical awareness, age and vocabulary knowledge controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Semantic_A	.37	.02	.53	.06***
3	Morphological_C	.45	.07***	.56	.03*

Note. Semantic_A = semantic radical awareness; Morphological_C = morphological construction

* $p < .05$

*** $p < .001$

In all of the regression analyses, the children's age and vocabulary knowledge jointly accounted for 35% of variance in single-character reading and 47% of variance in two-character reading. Phonetic radical awareness accounted for all of the variance of single-character reading (i.e., 14%) and two-character reading (i.e., 3%) that could be explained by onset-rime awareness (Table 9), indicting a complete mediation of phonetic radical awareness. In contrast, the observed relationship between children's morphological awareness and Chinese reading could not be completely explained by their semantic radical awareness. Specifically, homophone awareness accounted for additional 5% of single-character reading and 6% of two-character reading beyond that attributable to semantic radical awareness (Table 10). Morphological construction accounted for additional 7% of single-character reading and 3% of two-character reading beyond that attributable to semantic radical awareness (Table 11).

Associations among Metalinguistic Awareness, Radical Awareness and Chinese Reading

The primary purpose of this study was to investigate the relative contributions of phonological awareness and morphological awareness to different aspects of Chinese reading. A series of path analyses were conducted to assess the relative associations among the three metalinguistic awareness measures, two radical awareness measures and two Chinese reading measures. The path models were constructed by including the three metalinguistic awareness measures as predictors, children's age and vocabulary knowledge as control variables, and the two Chinese reading measures as dependent variables. Given that the homophone awareness task and morphological construction task were only moderately correlated, separate path models were built for each. The results of the path models are shown in Figures 3 and 4.

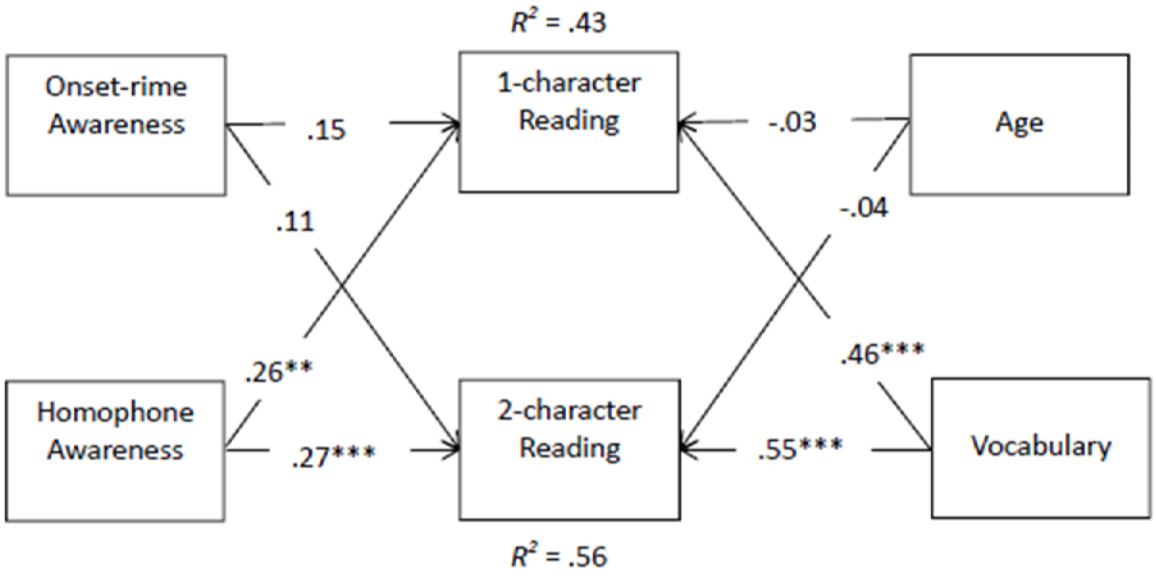


Figure 3.

A path model of the relative contributions of onset-rime awareness and homophone awareness to single-character reading and two-character reading with age and vocabulary knowledge controlled for.

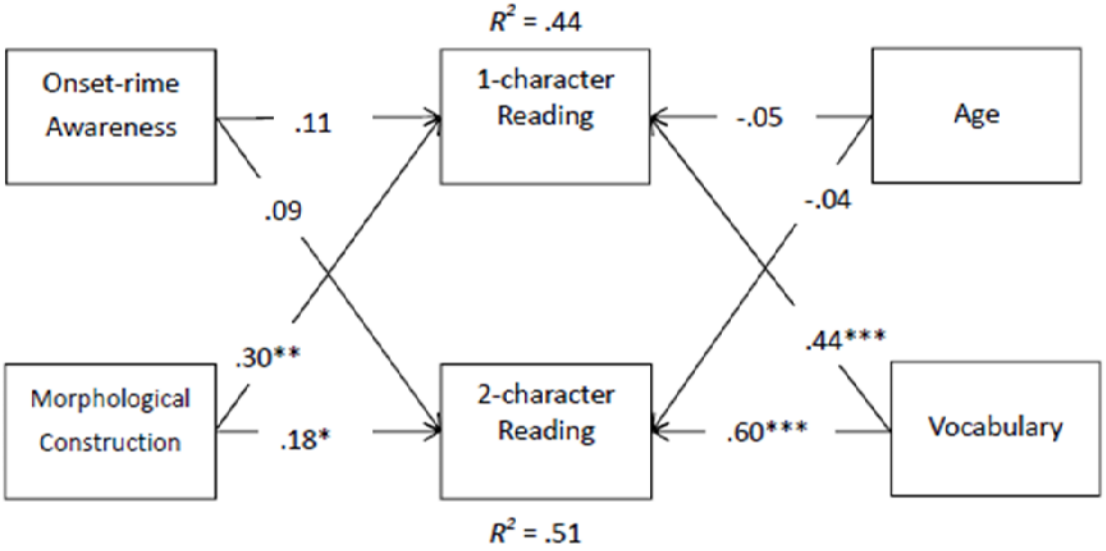


Figure 4.

A path model of the relative contributions of onset-rime awareness and morphological construction to single-character reading and two-character reading with age and vocabulary knowledge controlled for.

As shown in Figure 3, while homophone awareness was significantly related to both single-character reading, $\beta = .26$, $p < .01$, and two-character reading, $\beta = .27$, $p < .001$, onset-rime awareness was not related to either single-character reading, $\beta = .15$, $p > .05$, or two-character reading, $\beta = .11$, $p > .05$. As shown in Figure 4, while morphological construction was significantly related to both single-character reading, $\beta = .30$, $p < .001$, and two-character reading, $\beta = .18$, $p < .05$, onset-rime awareness was not related to either single-character reading, $\beta = .11$, $p > .05$, or two-character reading, $\beta = .09$, $p > .05$. These results, like those obtained in the previous analyses of the unique contribution, indicated that morphological awareness was of greater importance than phonological awareness in predicting Taiwanese third-graders' Chinese reading ability.

The second purpose of the present study was to examine how metalinguistic awareness is related to radical awareness. The answer to this question served as a starting point to test the mediating effect of radical awareness on the relationship between metalinguistic awareness and Chinese reading. Six types of potential mediations could be identified in this study, as shown in Table 12 below.

Table 12

Six types of potential mediations

Types	Independent Variable	→	Mediator	→	Dependent Variable
I	Onset-rime Awareness	→	Phonetic Radical Awareness	→	Single-character Reading
II	Onset-rime Awareness	→	Phonetic Radical Awareness	→	Two-character Reading
III	Homophone Awareness	→	Semantic Radical Awareness	→	Single-character Reading
IV	Homophone Awareness	→	Semantic Radical Awareness	→	Two-character Reading
V	Morphological Construction	→	Semantic Radical Awareness	→	Single-character Reading
VI	Morphological Construction	→	Semantic Radical Awareness	→	Two-character Reading

According to Baron and Kenny (1986), at least three requirements need to be fulfilled for mediation to be established. First, the independent variable should significantly predict the mediator. For evaluation of this requirement, a series of regression analyses was conducted to examine the effect of metalinguistic awareness on radical awareness. The results are given in Appendix H. Onset-rime awareness significantly predicted phonetic radical awareness, $\beta = .21$, $p < .05$ (*see* Table H-1), and homophone awareness and morphological awareness both significantly predicted semantic radical awareness, $\beta = .28$, $p < .01$ for homophone awareness (*see* Table H-2) and $\beta = .31$, $p < .01$ for morphological construction (*see* Table H-3).

Baron and Kenny (1986) also required that the independent variable significantly predict the dependent variable in the absence of the mediator. A series of regression analyses examines these relationships, controlling for children's age and vocabulary knowledge. The results are given in Appendix I. These analyses revealed that onset-rime awareness, homophone awareness and morphological construction all significantly predicted single-character reading, $\beta = .16$, $p < .05$ for onset-rime awareness (*see* Table I-1), $\beta = .27$, $p < .01$ for homophone awareness (*see* Table

I-2), and β = .32, $p < .001$ for morphological construction (*see* Table I-3). However, only homophone awareness and morphological construction significantly predicted two-character reading, β = .28, $p < .001$ for homophone awareness (*see* Table I-2), and β = .20, $p < .05$ for morphological construction (*see* Table I-2). Given the nonsignificant effect of onset-rime awareness on two-character reading, β = .12, $p > .05$ (*see* Table I-1), further tests of mediation involving the effect of onset-rime awareness on two-character reading were excluded.

Finally, Baron and Kenny (1986) also stated that the mediator should significantly predict the dependent variable over and above the independent variable. For this requirement, the measures of single- and two-character reading were regressed on radical awareness with children's metalinguistic awareness, age and vocabulary knowledge controlled. The results are given in Appendix J. The results showed that after controlling for onset-rime awareness, age and vocabulary knowledge, phonetic radical awareness significantly predicted single-character reading, β = .37, $p < .001$ (*see* Table J-1). After homophone awareness, age and vocabulary knowledge were controlled, semantic radical awareness did not significantly predict single-character reading, β = .16, $p > .05$ (*see* Table J-2), but significantly predicted two-character reading, β = .27, $p < .001$ (*see* Table J-2). Likewise, after morphological awareness, age and vocabulary knowledge were controlled, semantic radical awareness did not significantly predict single-character reading, β = .14, $p > .05$ (*see* Table J-3), but significantly predicted two-character reading, β = .27, $p < .01$ (*see* Table J-3). Since semantic radical awareness did not uniquely predict single-character reading after controlling for either homophone awareness or morphological construction, semantic radical awareness did not mediate the relationship between homophone awareness/morphological construction and single-character reading.

To summarize thus far, three potential mediations (Types I, IV and VI shown in Table 12)

were left for later analyses after Baron and Kenny's (1986) requirements for mediation were evaluated. Figures 5-7 illustrate these three mediation models. Sobel tests (1982) were used to test the significance of the mediating effect in these models.

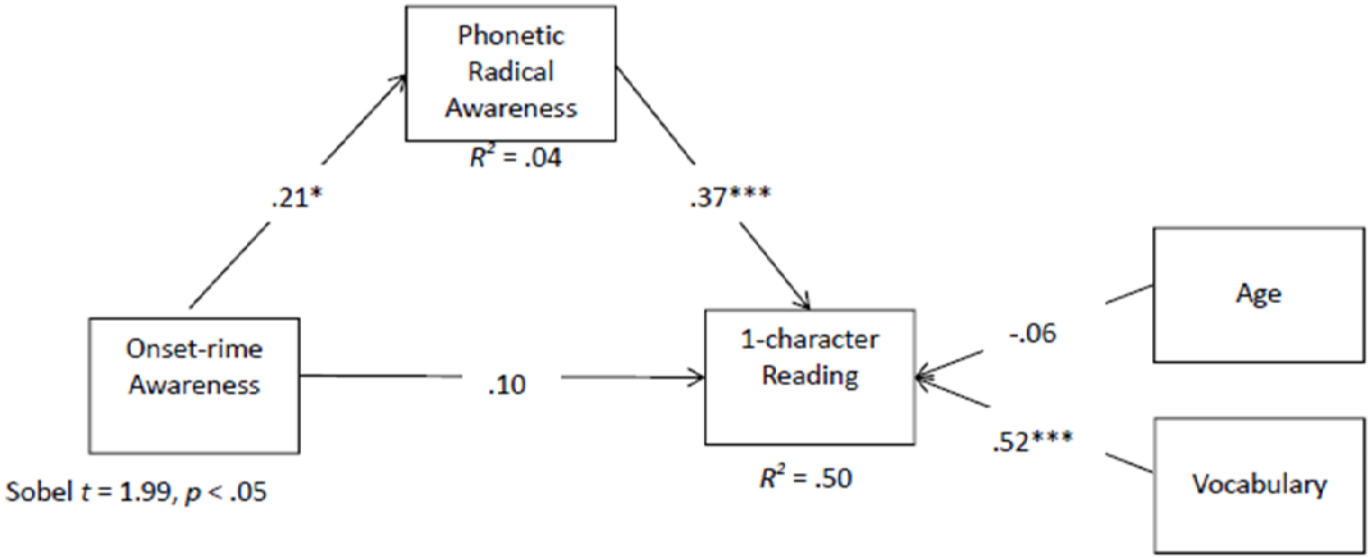


Figure 5.

A path model of the mediation of phonetic radical awareness between onset-rime awareness and single-character reading with age and vocabulary knowledge controlled

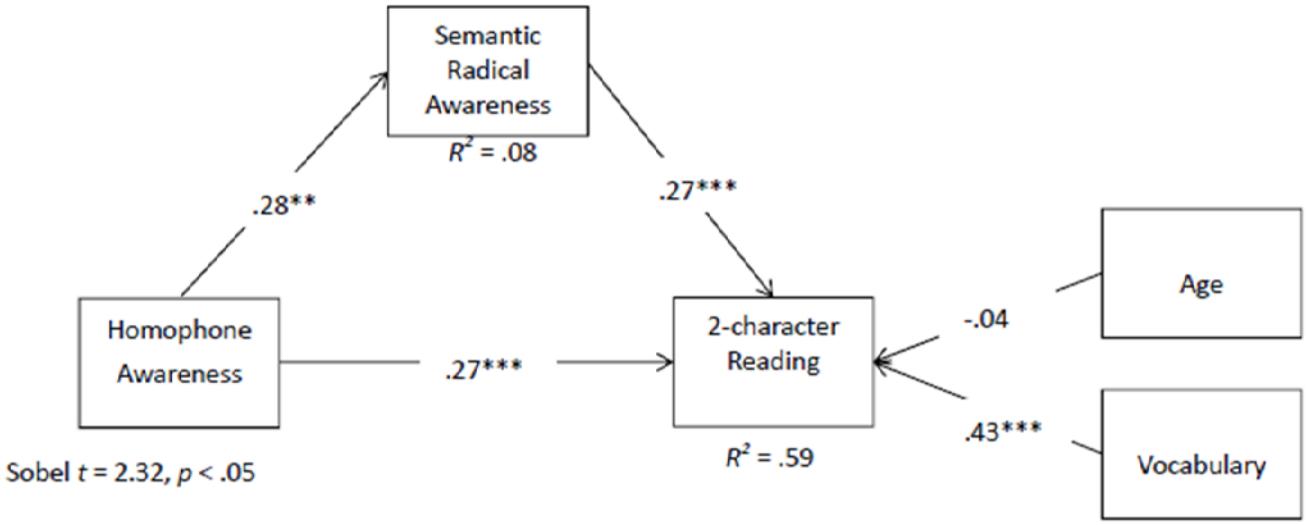


Figure 6.

A path model of the mediation of semantic radical awareness between homophone awareness and two-character reading with age and vocabulary knowledge controlled

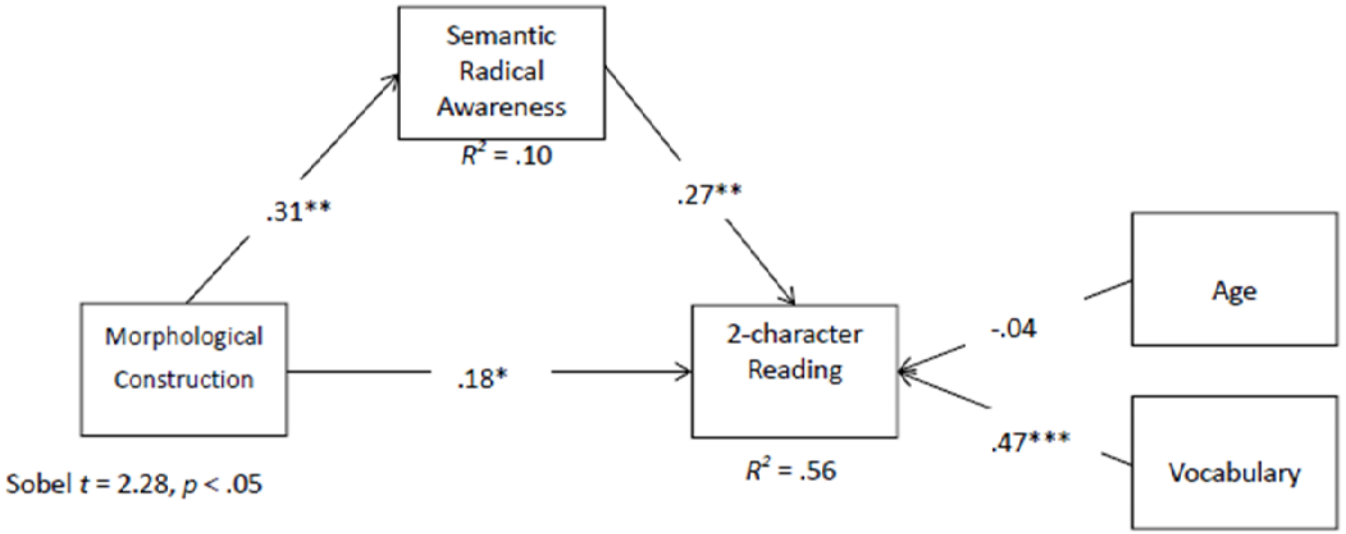


Figure 7.

A path model of the mediation of semantic radical awareness between morphological construction and two-character reading with age and vocabulary knowledge controlled

As shown in Figure 5, phonetic radical awareness completely mediated the relationship between onset-rime awareness and single-character reading, Sobel $t = 1.99$, $p < .05$, since the path coefficient from onset-rime awareness to single-character reading was no longer significant, $\beta = .10$, $p > .05$, after adding phonetic radical awareness to the path model. On the other hand, as revealed in Figures 6 and 7, semantic radical awareness only partially mediated the relationship between homophone awareness/morphological construction and two-character reading, Sobel $t = 2.32$, $p < .05$ for homophone awareness and Sobel $t = 2.28$, $p < .05$ for morphological construction, since the path coefficient from homophone awareness/morphological awareness to two-character reading remained significant, $\beta = .27$, $p < .001$ for homophone awareness and Sobel $t = .18$, $p < .05$ for morphological construction, after semantic radical awareness was included in the path model.

Chapter VI: Discussion

The present study was conducted to explore the relative roles of phonological awareness and morphological awareness, two important types of metalinguistic awareness, in Chinese single- and two-character reading. In addition, this study also examined the potential mediation of phonetic radical awareness and semantic radical awareness in the relationship between metalinguistic awareness and reading in Chinese. There were three main findings of the present study. First, the morphological awareness made a significantly greater contribution to single-character reading and two-character reading than did the phonological awareness measure. Second, phonological awareness significantly predicted phonetic radical awareness, while morphological awareness significantly predicted semantic radical awareness. Third, phonetic radical awareness completely mediated the relationship between phonological awareness and single-character reading, whereas semantic radical awareness only partially mediated the relationship between morphological awareness and two-character reading. These findings are discussed below.

The Relative Roles of Morphological Awareness and Phonological Awareness in Chinese Reading

It was hypothesized that phonological awareness would contribute more to single-character reading than to two-character reading, while morphological awareness would contribute more to two-character reading than to single-character reading. The results of the present study partially supported this hypothesis: the contribution of morphological awareness was greater than that of phonological awareness not only to two-character reading but to single-character reading as well. However, these findings are consistent with those of most previous studies on Chinese children in China and Hong Kong (e.g., Li, Shu, McBride-Chang, Liu, & Peng, 2010; McBride-Chang,

Cho, Liu, Wagner, Shu, Zhou, Cheuk, & Muse, 2005; Wang, Yang, & Cheng, 2009) in showing that Chinese children's reading abilities are more critically determined by morphological awareness than by phonological awareness. Specifically, in this study, children's homophone awareness and morphological construction, two important indicators of morphological awareness, were more strongly correlated with their ability to read single characters and two-character words than their onset-rime awareness, an indicator of phonological awareness. In addition, morphological awareness accounted for all of the variance in single-character reading and two-character reading that can be explained by phonological awareness even after vocabulary knowledge was partialled out. Possible explanations for the relative importance of phonological awareness and morphological awareness in single- and two-character reading are discussed below.

The relative roles of phonological awareness and morphological awareness in Chinese reading may be understood by looking closely at the two types of metalinguistic awareness. Phonological awareness contrasts with morphological awareness because the former taps phonological information in spoken words independent of their meanings, whereas the latter involves semantic processing plus phonological processing (Kuo & Anderson, 2006). The unequal roles of phonological awareness and morphological awareness in Chinese reading may be explained from three perspectives: one is related to the scope of abilities covered by phonological awareness and morphological awareness; another is associated with how the general linguistic information tapped by phonological awareness and morphological awareness interacts with the linguistic and orthographic features of Chinese; the last pertains to the more specific demands of the metalinguistic awareness tasks in relation to single- and two-character reading.

Scope of Abilities Interpretation

One possible reason why morphological awareness plays a more critical role in Chinese reading than phonological awareness is that the skill of phonological awareness is subsumed by morphological awareness. As proposed by Kuo and Anderson (2006), morphological awareness is a product of the interaction between phonological awareness and semantic awareness, which specifically refers to the organization of meanings in a language. In other words, morphological awareness is the ability to pair sounds with meanings. Mann (2000) asserted that "Being aware of morphemes must surely presuppose an awareness of phoneme- and syllable-sized units" (p. 144). In addition, some studies suggest that phonological awareness is a prerequisite skill for developing morphological awareness (e.g., Criddle & Durkin, 2001; Leonard, 1989). The literature cited above implies that once children acquire morphological awareness, they have already equipped themselves with phonological awareness. In light of this, it can be argued that the synergic effect of phonological awareness and semantic awareness, which are part of morphological awareness, is stronger than the effect of phonological awareness alone on Chinese reading.

Linguistic-General Interpretation

As noted earlier, phonological awareness deals with phonological information, whereas morphological awareness taps phonological information plus semantic knowledge. Chinese is a language rife with homophones. Identifying or decoding homophones based solely on phonological awareness is untrustworthy because phonological information itself is insufficient to distinguish among different characters with the same pronunciation. In addition, Chinese is an orthographically opaque language, where the symbol-to-sound correspondence is arbitrary. This arbitrariness in the symbol-to-sound correspondence makes reading Chinese through

phonological awareness inefficient and thus further discourages children from using phonological awareness to read Chinese, especially when other more reliable Chinese reading skills, such as morphological awareness, are accessible to them. As a consequence, the influence of phonological awareness on Chinese reading is limited.

On the other hand, semantic knowledge associated with morphological awareness could help children deal with the orthographic opaqueness of the Chinese language. As shown previously, the Triangle Model proposed by Yin and Weekes (2003) suggests that in addition to the non-semantic phonological route, reading Chinese could also be achieved via a lexical-semantic route. This lexical-semantic route allows a reader to screen out the candidate characters with a wrong pronunciation that are activated via the non-semantic phonological route. This lexical-semantic route is found to be especially useful in reading orthographically opaque words, whose phonology cannot be directly derived simply by phonetic decoding (Cho, McBride-Chang, & Park, 2008). This phenomenon is evident in different languages. For example, Nation and Snowling (1998) compared word reading abilities between a group of English-speaking children with poor semantic skills and their normally-developing peers matched for phonological decoding skills and found that semantically-deficient children were significantly inferior to their peers in reading low-frequency irregular words, which were supposed to be read with support from semantics. In their more recent study, Nation and Snowling (2004) proposed that semantic skills could serve as a basis on which, for example, the pronunciation of a homograph, such as *BOW* as in “he took a *bow* at the end of the performance” and “he took a *bow* and arrow from his bag”, can be disambiguated. Shibahara, Zorzi, Hill, Wydell and Butterworth (2003) found that Japanese speakers relied more on the lexical-semantic route than on the phonological route in reading orthographically opaque Japanese Kanji. They

argued that the pronunciations of orthographically opaque words are inconsistent with those of other words having similar spelling patterns and could not be decoded via phonological analogy; therefore, the reading of orthographically opaque words would benefit more from the lexical-semantic route than from the phonological route. Consistent with this argument, Cho, McBride-Chang and Park (2008) observed that phonological awareness, an index of taking the phonological route, uniquely explained the reading of Korean Hangul regular words, while morphological awareness, an index of taking the lexical-semantic route, uniquely explained the reading of Korean Hangul irregular words beyond phonological awareness. In addition, McBride-Chang, Shu, Zhou, Wat and Wagner (2003) suggested that flexibility in mapping meanings from the oral language onto print constitutes an important aspect of Chinese reading due to the low predictability of phonetic radicals in the pronunciation of Chinese characters. Furthermore, Chinese is known to be relatively semantically transparent at both the character and word levels. At the character level, the semantic radical provides a more reliable cue in decoding characters than does the phonetic radical (Shu, Chen, Anderson, Wu, & Xuan, 2003), while at the word level, the meanings of most compound words in Chinese are readily derivable from the meanings of their constituent morphemes (Chen, Hao, Geva, Zhu, & Shu, 2009; Packard, 2000). The semantic transparency in characters and words may thus encourage Chinese children to take the lexical-semantic route to reading. Taken together, it might be the semantic component of morphological awareness that better facilitates Chinese children in conquering the orthographic opaqueness of the Chinese language, which cannot be overcome through phonological awareness.

Task-demand-specific Interpretation

In addition to the general role of semantic processing that is associated with morphological

awareness, it is possible that the more specific task demands associated with the homophone awareness task and morphological construction task could also account for the greater importance of morphological awareness in Chinese reading. This "demand-specific" interpretation is provided for single-character reading and for two-character reading.

Single-character Reading

The homophone awareness task required children to be aware of semantic differences among characters with the same pronunciation that cannot easily be distinguished via phonological awareness. Phonetic radicals in Chinese usually provide unreliable phonological cues (Shu, Anderson, Wu, & Xuan, 2003); therefore, children may find it inefficient to use phonological awareness to read characters trough phonetic radical decoding. This may explain why homophone awareness was more important than phonological awareness in single-character reading. The morphological construction task, on the other hand, helped children detect the relationship between the constituent morphemes of a word, such as the modifier-head relationship, and combine those morphemes with new morphemes to create novel words following morphological rules. In a sense, the morphological construction task can be applied to disambiguate different meanings across spoken homophones (Tong & McBride-Chang, 2010). For example, the meaning of a spoken homophone /qiu2/ could mean 'request', 'ball', or 'prisoner' depending on the morphological or word context where it is embedded, such as /ken2qiu2/ 'request earnestly', /lan2qiu2/ 'basketball' and /qiu2fan4/ 'prisoner', respectively. In other words, children's performance on the morphological construction task may determine how well they distinguish homophones in the homophone awareness task, which, in turn, affects their single-character reading ability. If this was the case, the children's performance on the morphological construction task should not make any unique contribution to single-character

reading after their performance on the homophone awareness task was statistically controlled. Although not shown in the result section, a regression analysis revealed that the morphological construction task accounted for some of the residual variance in single-character reading that could not be explained by the homophone awareness task (*see* Table K-1 in Appendix K). Thus, the link between children's performance on the morphological construction task and their ability to read single characters could not be attributed completely to the individual differences on the homophone awareness task.

Then, how might the relationship between morphological construction and single-character reading be explained? One possible reason, according to Tong, McBride-Chang, Shu, and Wong (2009), is that the retrieval of a single character is sometimes facilitated by the awareness of the morphological structure in multi-character words containing that single character. Consistent with this possibility, in the single-character reading task, there were some episodic cases in which children attempted to retrieve a single character by referring to the word containing that character whether their attempts succeeded or failed. Another possible reason, as suggested by Chen et al. (2009), is that the sensitivity to morphemes in the oral language, which is necessary to succeed in the morphological construction task, helps children map morphemes onto characters more efficiently. Recall that the morphological construction task required children to create a novel word (e.g., 香化 /xiang1hua4/ 'fragrant-ify') by extracting the morpheme (e.g., 化 /hua4/ '-ify') from a real spoken word (e.g., 綠化 /lu4hua4/ 'green-ify') and combining it with another morpheme (e.g., 香 'xiang1' /fragrant/). Better performance on this task implies higher sensitivity to morphemes in the oral language, which, in turn, facilitates single-character reading by allowing an efficient mapping between morphemes and characters.

Despite the observed advantage of morphological awareness over phonological awareness

in predicting children's single-character reading, this finding was somewhat contradictory to that obtained in Hu's (2013) study, where the same single-character reading measure (i.e., *Graded Chinese Recognition Test*) and morphological construction task were administered to Taiwanese children at the same grade level (i.e., third grade). In her study, Taiwanese third graders' phonological awareness was found to significantly and concurrently explain unique variance in single-character reading over and above the effect of morphological awareness but not *vice versa*. The inconsistency in the results between Hu's study and the present study may be attributable partly to the way phonological awareness was measured. In the present study, children's onset-rime awareness was assessed only in the sound oddity format; however, Hu's (2013) study measured children's onset-rime awareness not only in the sound oddity format but also in the sound deletion format. The percentage scores obtained from the sound oddity task and sound deletion task in Hu's study were averaged into a composite score as an index for phonological awareness. The sound deletion task has been demonstrated to be the most difficult for young readers among other commonly used phonological awareness tasks, such as sound blending, sound oddity and sound segmenting (Stanovich, Cunningham, & Cramer, 1984). It is likely that children who perform well on the oddity task might otherwise encounter some difficulties in the sound deletion task; therefore, the sound deletion task should be better than the sound oddity task at discriminating good from poor phonological awareness. Thus, it might be that the more multifaceted phonological awareness index adopted in Hu's study captured more variability in phonological awareness which better predicted single-character reading than in the present study.

Another possible reason for the inconsistent results may pertain to Chinese children's developmental transition from using phonological awareness to using morphological awareness in reading Chinese. The mean age of the children was 104.77 months in Hu's study, while it was

110.61 months in the present study, which was about six months older than that of the children in Hu's study. The six-month interval suggests a difference in the amount of exposure to formal reading instructions; i.e., the children in the present study had received one semester of formal reading instructions more than those in Hu's study. In the same study, Hu (2013) further found that grade 3 phonological awareness ceased to predict grade 5 Chinese reading in the presence of grade 3 reading. By contrast, grade 3 morphological awareness could predict grade 5 reading even when grade 3 reading was taken into account. The results suggest a developmental shift in the use of metalinguistic awareness from phonological awareness to morphological awareness in Chinese reading between grade 3 and grade 5. Hu argued that such a shift to morphological awareness may arise from a greater need to cope with an increasing number of novel poly-morphemic words in the textbooks that did not belong to children's oral vocabulary. In light of this, it might be that the turning point for this metalinguistic awareness shift happened to be the age of the children in the present study. This could have partially explained the inconsistent results shown above.

Two-character Reading

Similar to the results for single-character reading, both homophone awareness and morphological construction bore a stronger relationship to two-character reading than did phonological awareness. The homophone awareness task demanded that children identify, for example, 警 /jing3/ in 警惕 /jing3ti4/ 'vigilant' as being the same morpheme as 警 /jing3/ in 警告 /jing3gao4/ 'warning', but as being a different morpheme from 景 /jing3/ in 景觀 /jing3guan1/ 'landscape'. The understanding that 警 and 景, though sharing the same pronunciation, differ in meaning could increase the rate of correctly reading 警惕 /jing3ti4/ by excluding the two-character words consisting of the homophonic morpheme 景 /jing3/ in the

mental lexicon as the possible reading for 警惕 /jing3ti4/. On the other hand, the morphological construction task allowed children to obtain the meaning of 警惕 by analyzing its morphological structure and constituent morphemes and thus could help them recognize the two-character word. In addition, the access to the meaning of a two-character word through morphological construction could possibly serve as a strategy for children to self-monitor their reading errors caused by regularizing phonetic radicals. For example, in the present study, many children read the two-character word 警惕 /jing3**ti4**/ 'vigilant' as /jing3**yi4**/ the first time, where the second syllable transcribed the phonetic radical 易 /yi4/ of the target character 惕 /ti4/. Realizing that the combination of the two morphemes /jing3/ and /yi4/ did not constitute a meaningful word in spoken Chinese, these children self-corrected the misread syllable /yi4/ to a phonologically-similar syllable /ti4/, which was the correct pronunciation of 惕.

As for the role of phonological awareness in two-character reading, one may argue that the children in the present study may read a two-character word as if they were reading two individual single characters, which is evidenced by the high correlation between single-character reading and two-character reading. As has been shown previously, using phonological awareness to read single characters is not very reliable, let alone using it to read two-character words; therefore, the weak correlation between onset-rime awareness and two-character reading obtained in the present study was not unexpected.

Although the present study showed that morphological awareness appeared to be more crucial than phonological awareness in determining Chinese children's reading success, it might be too simplistic to conclude that phonological awareness has no effect on Chinese reading. Many previous studies have documented the importance of phonological awareness in early Chinese reading development (e.g., Ho & Bryant, 1997; Hu & Catts, 1998; Shu, Peng, &

McBride-Chang, 2008; Siok & Fletcher, 2001). These studies did not include morphological awareness measures; thus, the researchers were unable to evaluate the relative importance of phonological awareness and morphological awareness. By contrast, the present study examined both types of metalinguistic awareness; thus, the observed advantage of morphological awareness in Chinese reading may just be a relative one. Indeed, this study found a statistically significant, though weak, correlation between phonological awareness and single- and two-character reading in the absence of morphological awareness. In addition, the simulation of a word reading activity under the connectionist model framework (Plaut, McClelland, Seidenberg, & Patterson, 1996) demonstrates that phonological process is initially implemented in the orthography-phonology mapping followed by a redistribution of labor from phonological process to semantic process in the later stages of word reading. This might also attest to the necessity of phonological awareness, which taps phonological processes, in beginning reading of Chinese, after which morphological awareness, which taps semantic processes, comes to play a more major role.

The above discussion focuses on the unique contribution of the two morphological awareness tasks to single-character reading and two-character reading on top of the phonological awareness task. It is also important to explore if one morphological awareness task (either the homophone awareness or the morphological construction task) affects both reading measures over and above the other. The unique contribution of either morphological awareness task, if observed, can constitute a critical piece of evidence supporting the task-demand-specific interpretation. Though not shown in the results section, a series of multiple regression analyses revealed that homophone awareness explained unique variance in both single-character reading and two-character reading over and above morphological construction and vice versa (*see*

Appendix K). In other words, the task demands associated with the two morphological awareness measures described above are all important in learning to read Chinese.

One thing worth noting is that once vocabulary knowledge was controlled for, the contribution of morphological construction to single-character reading became far greater than its contribution to two-character reading, whereas the contribution of homophone awareness to single-character reading remained comparable to its contribution to two-character reading. In other words, vocabulary knowledge might shape the four pairs of relationships between homophone awareness/morphological construction and single-character reading/two-character reading. To understand the effect of vocabulary knowledge on the aforementioned relationships between morphological awareness and Chinese reading, it is necessary to look at the relation of morphological awareness to vocabulary knowledge. To begin with, both homophone awareness and morphological construction have been demonstrated to bear a reciprocal relationship to vocabulary knowledge in Chinese children. For example, Liu, McBride-Chang, Wong, Shu and Wong (2013) suggested that the acquisition of homophone awareness requires a sufficient amount of vocabulary knowledge that enables children to realize the existence of homophones and recognize homophones with the same and different meanings. Moreover, homophone awareness facilitates children's vocabulary development by making them realize that the meanings of morphemes with the same pronunciation are not necessarily the same across different words. Likewise, vocabulary knowledge can foster the development of morphological construction. Well-developed vocabulary knowledge allows children to detect morphological regularity across different words. Through morphological construction, children can expand their vocabulary knowledge by inferring the meaning of a new vocabulary item based on its constituent morphemes and morphological structure. Collectively, it appears that morphological

awareness and vocabulary knowledge are different indicators of the same underlying construct, i.e., semantic knowledge. Since Chinese reading, as demonstrated previously, should be accomplished primarily via meaning due to the orthographic opaqueness of Chinese, it is plausible that vocabulary knowledge, like morphological awareness, contributes to Chinese reading through its relation to semantic knowledge.

The above argument suggests that morphological awareness, vocabulary knowledge and Chinese reading all share the variance that is associated with semantic knowledge. However, how the semantic-associated variance is shared by morphological awareness, vocabulary knowledge and Chinese single vs. two character reading may differ. Specifically, the homophone awareness task and single-character reading task tap semantics at the single morpheme level, whereas the morphological construction task and two-character reading task tap semantics at the morphological structure level. It has been estimated that mono-morphemic words and bi-morphemic words account for about 5.68% and 72.05% of commonly-used Chinese words, respectively (People's Republic of China, State Language and Letters Committee, 2008). The larger percentage of bi-morphemic compound words in Chinese suggests that Chinese vocabulary is more likely to tap semantics at the morphological structure level than at the single morpheme level. Hence, the greater contribution of morphological construction to single-character reading, as opposed to two-character reading, may simply reflect the fact that controlling for vocabulary knowledge removes more variance shared by the morphological construction task and two-character reading task than that shared by the morphological construction task and single-character reading task. However, vocabulary knowledge explained no more variance shared by homophone awareness and single-character reading than that shared by homophone awareness and two-character reading; thus, the contribution of homophone

awareness to single-character reading was comparable to its contribution to two-character reading.

Metalinguistic Awareness and Radical Awareness

Another important purpose of the present study was to test the potential mediation of radical awareness in the relationship between metalinguistic awareness and Chinese reading. Before the mediation of radical awareness could be established, it is important to demonstrate that metalinguistic awareness contributed to radical awareness and Chinese reading. The results of the regression and path analyses showed that phonological awareness significantly predicted phonetic radical awareness, while morphological awareness significantly predicted semantic radical awareness.

Phonological Awareness and Phonetic Radical Awareness

The present study found that phonological awareness significantly predicted phonetic radical awareness, suggesting that phonological awareness may be necessary, though not sufficient, to developing phonetic radical awareness. Chinese children's acquisition of phonetic radicals has been argued to be driven partly by statistical learning (Shu & Wu, 2006). More reading experience with printed characters implies a higher chance of learning the recurring parts within characters that convey phonological information, i.e., phonetic radicals. For example, the phonetic radical 青 /qing1/ provides full phonological information for 清, 鯖, 蜻, 氰 /qing1/, only rhyme information for 精, 菁, 睛, 箐 /jing1/, only onset information for 倩, 蒨, 椌 /qian4/ and only syllable information for 情 /qing2/, 請 /qing3/, 凊 /qing4/. Children who encounter more characters of the 青 family in print are more likely to notice that 青 can provide full or partial phonological information for different characters containing it. However, identifying the phonological cueing function of a phonetic radical may depend on phonological

awareness to some extent. This process is especially true for the identification of the phonetic radicals of semi-regular characters. For example, children with poorer phonological awareness may, at best, only know the visual relationship between the phonetic radical 青 /qing1/ and the semi-regular characters containing it (e.g., 精, 菁, 睛, 箐, 倩, 蒨, 棈) without appreciating its phonological cueing function. Consequently, the acquisition of the phonetic radical 青 is hindered. By contrast, children with better phonological awareness are more readily able to detect the phonological similarity (e.g., rhyming or alliteration) between a character and its phonetic radical, thus enhancing the development of phonetic radical knowledge. In other words, to successfully acquire the awareness of phonetic radicals, one has to be aware of not only the repetitiveness of its visual form but also its phonological cueing function through phonological awareness.

Morphological Awareness and Semantic Radical Awareness

This study also found that morphological awareness was related to semantic radical awareness, indicating that morphological awareness may aid children in developing semantic radical awareness. As with morphological awareness, semantic radical awareness also involves the processing of semantic knowledge, only that it is implemented at the print level, while morphological awareness at the spoken level. Spoken language experience usually sets the stage for developing written language skills (Catts & Kamhi, 1998); therefore, orally-based morphological awareness may be a precursor to print-based semantic radical awareness. Theoretically, morphological awareness helps children obtain the meaning of a spoken morpheme by sensitizing them to the semantic difference across homophones (i.e., homophone awareness) and by having them construe the morphological context where the morpheme is embedded (i.e., morphological construction). When learning the printed character representing

the spoken morpheme, children can more readily associate its meaning derived from morphological awareness to its semantic radical, facilitating the acquisition of semantic radical awareness. However, the contribution of morphological awareness to semantic radical awareness may be limited to transparent semantic radicals, which provide explicit semantic information, such as 木 'wood-related' in 樹 /shu4/ 'tree'. On the other hand, morphological awareness might play a trivial role in the awareness of opaque semantic radicals, which do not provide any cue to character meaning, such as 土 'soil-related' in 增 /zeng1/ 'increase'. Fortunately, most of the semantic radicals in Chinese are transparent (Ho, Ng, & Ng, 2003), thus further attesting to the importance of morphological awareness in developing semantic radical awareness.

Mediation of Radical Awareness in the Relationships between Metalinguistic Awareness and Chinese Reading

The final purpose of the present study was to test whether radical awareness mediated the relationship between metalinguistic awareness and Chinese reading. For this purpose, Baron and Kenny's (1986) requirements of mediation and Sobel's test (1982) were adopted to test these mediating effects. The results of the mediation tests revealed complete mediation by phonetic radical awareness of the relationship between phonological awareness and single-character reading and partial mediation by semantic radical awareness of the relationship between morphological awareness and two-character reading. The various mediation patterns are discussed below.

Mediation of Phonetic Radical Awareness in the Relationship between Phonological Awareness and Single-character Reading

Although previous studies of Chinese children's reading ability have implicitly attributed the association between phonological awareness and character reading to the mediation by

phonetic radical awareness (e.g., Ho & Bryant, 1997; Hu, 2013; Hu & Catts, 1998), very few studies, if any, have directly investigated such a mediating effect. Reading Chinese characters through phonetic radical decoding has been demonstrated in previous research (Anderson, Li, Ku, Shu, & Wu, 2003; Ho, Ng, & Ng, 2003; Ho & Bryant, 1997; Shu, Anderson, & Wu, 2000). Consistent with these findings, the present study also revealed that phonetic radical awareness contributed to single-character reading; however, phonetic radical awareness did not significantly predict two-character reading after controlling for vocabulary knowledge. This result cannot be attributed completely to the nature of the test stimuli in the single-character and two-character reading tasks because the two reading tasks contained a fairly large percentage of characters with a regular or semi-regular phonetic radicals (i.e., around 69.5% in the single-character reading task and around 69.8% in the two-character reading task). The lack of predictive power of phonetic radical awareness in two-character reading may just reflect the fact that reading two-character words in Chinese involves little decoding of the phonetic radical. As discussed below, two-character reading should rely more on semantic radical decoding.

Given that in the present study onset-rime awareness was found to predict phonetic radical awareness, which, in turn, was predictive of single-character reading, there existed a possibility that the observed contribution of phonological awareness to single-character reading might be a function of the mediation by phonetic radical awareness. The present study directly tested and confirmed this possibility in showing that the relation of phonological awareness to single-character reading was completely mediated by phonetic radical awareness. There are two possible ways to interpret the mediating effect of the phonetic radical awareness. Firstly, according to Hu and Catts (1998), phonological awareness may be necessary to segment the phonetic radical into its phonological component, such as onsets and rimes. The segmented

phonological component can be combined with other phonological component to obtain the pronunciation of the character. For example, phonological awareness can help children segment the phonetic radical 惠 /hui4/ into its onset /h/ and rime /ui/ before its rime is combined with another onset /s/ to derive the pronunciation of the character 穗 /sui4/. Secondly, Ho and Bryant (1997) argued that phonological awareness allows Chinese children to learn how characters with the same phonetic radical sound identical (e.g., 精 /jing1/ and 睛 /jing1/), similar (e.g., 精 /jing1/ and 清 /qing1/) or different (e.g., 精 /jing1/ and 倩 /qian4/) by making orthographic analogies between those characters, just as English-speaking children apply phonological awareness to facilitate their orthographic analogies in reading words (Goswami, 1990). In addition, orthographic analogies by the phonetic radical have been shown to be a common strategy Chinese children use in learning to read characters (Ho, Wong, & Chan, 1999). This being said, phonological awareness may be important in determining how well Chinese children exploit orthographic analogies in reading characters. Taken together, the mediation of phonetic radical awareness may account for the mechanism by which phonological awareness contributes to Chinese character reading.

Mediation of Semantic Radical Awareness in the Relationship between Morphological Awareness and Two-character reading

In addition to phonetic radical awareness, semantic radical awareness constitutes another important ability to read Chinese. Many previous studies have shown that Chinese readers make use of semantic radicals in reading Chinese (e.g., Ho, Ng, & Ng, 2003; Shu & Anderson, 1997; Li, Anderson, Nagy, & Zhang, 2002). Consistent with this research finding, the present study also showed that children's semantic radical awareness significantly predicted their reading ability. However, the prediction from semantic radical awareness was only limited to

two-character reading but was not observed in single-character reading once morphological awareness was considered. This may be due to the bi-morphemic nature of the test words shared by the semantic radical awareness task and two-character reading task. The processing of bi-morphemic words presumably involves the analysis of morphological structure to some extent, which is lacking in the process of mono-morphemic words. Because the single-character reading task focused on mono-morphemic words, its connection with the semantic radical awareness task was not as strong as the connection between the semantic radical awareness task and two-character reading task, both of which targeted bi-morphemic words. Another possibility is that compared to single-character reading, two-character reading involves more semantic processing, which is necessary to complete the semantic radical awareness task used in the present study. For example, when reading the single character 花 /hua1/, one cannot easily tell whether it means 'flower' or 'spend' due to its homographic nature. However, when this character comes with another character, such as 瓣 /ban4/ 'petal' in 花瓣 /hua1ban4/ 'flower petal' and 錢 /qian2/ 'money' in 花錢 /hua1qian2/ 'spend money', its meaning can be fixed based on its semantic relation with the other character.

Since the children's performance on the two morphological awareness tasks determined how well they developed semantic radical awareness, it is plausible that morphological awareness affected two-character reading through its influence on semantic radical awareness. Semantic radical awareness, however, only partially mediated the relationship between morphological awareness and two-character reading. There must be some residual variance in two-character reading that cannot be explained by semantic radical awareness but by morphological awareness. One possible reason for the partial mediation of semantic radical awareness may be that the semantic radicals tested in the semantic radical awareness task were

not sensitive enough to capture all variability in two-character reading. Recall that there were only 10 trials in the semantic radical awareness task; thus, the semantic radicals used in this task may not be sufficiently representative. Indeed, a close examination on the two-character reading task revealed that only 37.2% (16 out of 43) of the words contained the semantic radicals that also appeared in the semantic radical awareness task. In other words, the semantic radical awareness task used in this study may underestimate children's ability to read two-character words through semantic radical decoding, which leads to the false impression that children rely more on morphological awareness than semantic radical awareness in the two-character reading task.

The partial mediation of semantic radical awareness might also be accounted for from a developmental perspective. It has been demonstrated that Chinese children develop morphological awareness as early as kindergarten (Chung & Hu, 2007); however, they do not evidence semantic radical awareness until they reach third grade (Ho, Ng, & Ng, 2003; Shu & Anderson, 1997). In addition, Zhang, McBride-Chang, Tong, Wong, Shu and Fong (2012) found that Chinese children displayed a developmental shift from relying on morphological awareness to using semantic radical awareness in Chinese reading as they got older. The children of the present study were third graders and thus may just be beginning to learn to use semantic radicals to read Chinese. Before this time, they relied more on morphological awareness, which allowed them to directly map meanings onto their corresponding characters. In other words, the children in the present study did not completely abandon morphological awareness in reading even though semantic radical awareness became available. This might explain why semantic radical awareness only partially mediated the relationship between morphological awareness and two-character reading.

Conclusions, Limitations and Implications

In summary, the present study showed that morphological awareness was more important than phonological awareness in predicting individual differences not only in single-character reading but also in two-character reading among Taiwanese third graders. Although phonological awareness may indirectly aid initial reading development in Chinese children via its impact on phonetic radical awareness, its importance seems to be largely downplayed when children were facing a plethora of homophones and irregular characters in the Chinese language. On the contrary, morphological awareness may help children overcome the reading hurdle caused by the two aforementioned features of Chinese through semantic processing. In addition, the semantic transparency of most semantic radicals and compound words in Chinese may further encourage Chinese children to capitalize on morphological awareness in reading. Semantic radical awareness, though facilitating Chinese reading, may not completely replace the role of morphological awareness in affecting Taiwanese third graders' reading ability partly because it was still developing in these children.

Some limitations should be acknowledged in the present study. First, no causal relationship between metalinguistic awareness and Chinese reading could be inferred in the present study due to its correlational and cross-sectional design. While metalinguistic awareness is facilitative of reading development, it may also benefit from reading experience. For example, previous studies have shown that the experience with print helps children develop better phonological awareness (Mann, 1986; Castles, Wilson, & Coltheart, 2011; Castles & Coltheart, 2004) and morphological awareness (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003; Wu, Anderson, et al., 2009). For the causal relationship between metalinguistic awareness and Chinese reading to be established, future studies should employ an empirical and longitudinal design that includes a careful

comparison between the training and control groups. Second, the present study did not include other variables demonstrated to be important in Chinese character or word reading, such as phonological memory and speeded naming, thus limiting the ability to explain the uniqueness of phonological awareness and morphological awareness in Chinese reading. Third, the bi-morphemic nature of the semantic radical awareness task might have augmented its influence on two-character reading while restricting its impact on single-character reading; therefore, in addition to two-character words, future semantic radical awareness tasks should also include single characters as the test stimuli in order to clarify whether the association between semantic radical awareness and two-character reading reflected the truth or was just the result of the experimental artifact. Moreover, the narrow range of semantic radicals in the semantic radical awareness task may also underestimate children's ability to use semantic radicals in the reading measures of the present study; thus, future studies should test a broader range of semantic radicals. Fourth, the phonological awareness task only used the sound oddity format and was measured only at the onset-rime level; thus, it may not be sensitive enough to capture unique variance predictive of Chinese reading over and above morphological awareness. Apart from the sound oddity format, phonological awareness can also be measured in the sound deletion, sound blending and sound segmenting formats (Adams, 1990), each of which may capture differential variance in reading. In addition, tone awareness comprises another important ability in Chinese reading development; however, the originally-proposed tone awareness task was dropped out of the present study due to a ceiling effect observed in a pilot study (*see* Appendix A). Given these considerations, future studies on Chinese children should include a more difficult tone awareness task and adopt different formats of phonological awareness measures. Fifth, the homophone awareness task and morphological construction task did not appear to measure a single construct

even though they were both intended to measure morphological awareness; therefore, the status of the construct of morphological awareness is hard to determine. Future studies may include other tasks that are intended to measure morphological awareness, such as compound awareness and morpheme production (Zhou, McBride-Chang, Fong, Wong, & Cheung, 2012). A factor analysis using these tasks would be able to determine if these tasks really loaded onto one factor, i.e., morphological awareness. Finally, it is also necessary to explore when and how Chinese children transition from using phonological awareness to using morphological awareness during the course of reading development. Such an exploration calls for a longitudinal study which follows Chinese children at least from third grade to fifth grade, as shown in Hu's (2013) study.

Despite these limitations, the present study has been the first study that examines the contributions of phonological awareness and morphological awareness to single-character reading and to two-character reading in Chinese children, as well as the potential mediation by phonetic and semantic radical awareness of the relationship between metalinguistic awareness and Chinese reading development. The comparison of single-character and two-character reading and the inclusion of radical awareness measures were not considered in previous studies on the relative roles of phonological awareness and morphological awareness in Chinese reading; thus, the present study provides a more comprehensive picture of how Chinese children learn to read. Furthermore, the results of the present study can also inform educational practice in teaching Chinese children prerequisite reading skills. Since the orally-based morphological awareness tasks used in the present study were found to significantly predict Chinese reading, Chinese children would benefit from the oral training of morphological awareness in addition to the print training of morphological awareness that has been emphasized in the current Chinese textbooks in Taiwan.

References

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

Anderson, R. C., Li, W., Ku, Y.-M., Shu, H, & Wu, N. (2003). Use of partial information in learning to read Chinese characters. *Journal of Educational Psychology*, *95(1)*, 52-57.

Anthony, J. L., & Francis, D. J. (2005). Development of phonological awareness. *Current Directions in Psychological Science*, *14*, 255-259.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*, 1173-1182.

Bowey, J. A., & Patel, R. K. (1988). Metalinguistic ability and early reading achievement. *Applied Psycholinguistics*, *9*(4), 367-383.

Bradley, L., & Bryant, P. E. (1983). Categorising sounds and learning to read: A causal connection. *Nature*, 301, 419-421.

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

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

Carlisle, J. F., McBride-Chang, C., Nagy, W., & Nunes, T. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly*, *45*(4), 464-487.

Catts, H, & Kamhi, A. (1998). *Language and reading disabilities*. Boston: Allyn & Bacon.

Chall, J. (1983). *Stages of reading development.* New York: McGraw-Hill.

Chen, M. J., & Yuen, J. C.-K. (1991). Effects of Pinyin and script type on verbal processing: Comparisons of China, Taiwan, and Hong Kong experience. *International Journal of Behavioral Development*, *14*(4), 429-448.

Chen, X., Hao, M., Geva, E., Zhu, J., & Shu, H. (2009). The role of compound awareness in Chinese children's vocabulary acquisition and character reading. *Reading and Writing*, *22*(5), 615-631.

Chinese Knowledge Information Processing Group (CKIP) (1993). *Corpus-based frequency count of words in journal Chinese*. Taipei: Academia Sinica.

Cho, J. R., McBride-Chang, C., & Park, S. G. (2008). Phonological awareness and morphological awareness: Differential associations to regular and irregular word recognition in early Korean Hangul readers. *Reading and Writing*, *21*, 255-274.

Chow, B.W.-Y., McBride-Chang, C., Cheung, H. & Chow, C.S.-L. (2008). Dialogic reading and morphology training in Chinese children: Effects on language and literacy. *Developmental Psychology*, *44*, 233-244.

Chung, W.-L., & Hu, C.-F. (2007). Morphological awareness and learning to read Chinese. *Reading and Writing*, *20*, 441-461.

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

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological*

Review, *108*, 204-256.

Criddle, M. J., & Durkin, K. (2001). Phonological representation of novel morphemes in children with SLI and normally developing children. *Applied Psycholinguistics*, *22*, 363-382.

DeFrancis, J. (1984). *The Chinese language*. Honolulu: University of Hawaii Press.

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

Ehri, L. C. (2012). Why is it important for children to begin learning to read in kindergarten? In S. Suggate & E. Reese (Eds.). *Contemporary debates in childhood education and development* (pp. 171-180). New York: Routledge.

Feldman, L. B., & Siok, W. W. T. (1999). Semantic radicals contribute to the visual identification of Chinese Characters. *Journal of Memory and Language*, *40*, 559-576.

Frith,V. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall,&M. Coltheart (Eds.), *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading* (pp. 301-330). London: Lawrence Erlbaum Associates, Inc.

Fung, R. S. Y. (2009). Characteristics of Chinese in relation to language disorders. In S. P. Law, B. Weekes, & A. Wong (Eds.), *Language disorders in speakers of Chinese* (pp. 1-18). Clevedon, England: Multilingual Matters.

Goswami, U. (1990). A special link between rhyming skills and the use of orthographic analogies by beginning readers. *Journal of Child Psychology and Psychiatry*, *31*, 301-311.

Goswami, U., & Bryant, P. E. (1990). *Phonological skills and learning to read*. Hillsdale, NJ: Erlbaum.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education*, *7*, 6-10.

Ho, C. S.-H. (1997). The importance of phonological awareness and verbal short term memory to children's success in learning to read Chinese. *Psychologia*, *40*, 211-219.

Ho, C. S.-H., & Bryant, P. (1997). Phonological skills are important in learning to read Chinese. *Developmental Psychology*, *33*, 946-951.

Ho, C. S. -H., Chan, D. W., Lee, S. H., Tsang, S. M., & Luan, V. H. (2004). Cognitive profiling and preliminary subtyping in Chinese developmental dyslexia. *Cognition*, *91*, 43-75.

Ho, C. S. -H., Ng, T. T., & Ng, W. K. (2003). A "radical" approach to reading development in Chinese: The role of semantic radicals and phonetic radicals. *Journal of Literacy Research*, *35*(3), 849-878.

Ho, C. S.-H., Wong, W.-L., & Chan, W.-S. (1999). The use of orthographic analogies in learning to read Chinese. *Journal of Child Psychology and Psychiatry*, *40*, 393-403.

Hong, L.-Y. (1999). Research on the relationship between visual awareness of Chinese and language ability in elementary school children. In H.- W. Ko, & L.-H. Hong (Eds.). *Proceedings of the conference on the diagnosis for reading difficulties in elementary school children* (pp. 35-57). Research Center of Cognitive Science, National Chungcheng University. (In Chinese)

Hoosain, R. (1991). *Psycholinguistic implications for linguistic relativity: A case study of*

Chinese. Hillsdale, N.J.: L. Erlbaum.

Hu, C. F. (2013). Predictors of reading in children with Chinese as a first language: a developmental and cross-linguistic perspective. *Reading and Writing*, *26* (2), 163-187.

Hu, C. F., & Catts, H. W. (1998). The role of phonological processing in early reading ability: What we can learn from Chinese. *Scientific Studies of Reading*, *2*(1), 55-79.

Huang, H. S. (2004). *Graded Chinese character recognition test*. Taipei, Taiwan: Psychological Publishing.

Huang, H. S., & Hanley, J. R. (1995). Phonological awareness and visual skills in learning to read Chinese and English. *Cognition*, *54*, 73-98.

Huang, H. S., & Hanley, J. R. (1997). A longitudinal study of phonological awareness, visual skills, and Chinese reading acquisition among first graders in Taiwan. *International Journal of Behavioral Development*, *20*, 249-268.

Hue, C.-W. (1992). Recognition processes in character naming. In H.-C. E. Chen & Ovid J. L. Tzeng (eds.) *Language processing in Chinese* (pp. 93-107). Advances in Psychology 90. Amsterdam: North-Holland.

Institute of Language Teaching and Research [of China]. (1986). *A frequency dictionary of modern Chinese*. Beijing, China: Beijing Language Institute Press.

Kline, P. (1999). *The handbook of psychological testing* (2nd ed.). London: Routledge.

Ko, H., & Lee, J.-R. (1997). Phonological awareness and learning to read in illiteral adults. *Journal of the National Chung-Cheng University*, *7*, 29-47.

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

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

Law, S. P. (1997). The role of the phonetic radical in constructing Chinese logographs: Data from Cantonese colloquial characters. In *Poster presented at the 8th International Conference on Cognitive Processing of Asian Languages & Symposium on Brain, Cognition, and Communication, Nagoya, Japan*.

Law, S. P., & Or, B. (2001). A case study of acquired dyslexia and dysgraphia in Cantonese: Evidence for nonsemantic pathways for reading and writing in Chinese. *Cognitive Neuropsychology*, *18*(8), 729-748.

Law, S. P., Wong, W., & Chiu, K. (2005). Preserved reading aloud with semantic deficits: Evidence for a non-semantic lexical route for reading Chinese. *Neurocase*, *11*(3), 167-175.

Lee, T., Ching, P.C., Chan, L. W., Cheng, Y. H., & Mak, B. (1995). Tone recognition of isolated Cantonese syllables. *IEEE Transactions on Speech and Audio Processing*, *3*(3), 204-209.

Leonard, L. (1989). Language learnability and specific language impairment in children. *Applied Psycholinguistics*,*10*, 179-202.

Leong, C. K., Cheng, P. W., & Tan, L. H. (2005). The role of sensitivity to rhymes, phonemes and tones in reading English and Chinese pseudowords. *Reading and Writing*, *18*(1), 1-26.

Li, C., & Thompson, S. (1981). *Mandarin Chinese: A functional reference grammar*. Los Angeles: University of California Press.

Li, H., & Rao, N. (2000). Parental influences on Chinese literacy development: A

comparison of preschoolers in Beijing, Hong Kong, and Singapore. *International Journal of Behavioral Development*, *24*(1), 82-90.

Li, H., Shu, H., McBride-Chang, C., Liu, C., & Peng, H. (2010). Chinese children's character recognition: Visuo-orthographic phonological processing and morphological skills. *Journal of Research in Reading*, *35* (3), 287-307.

Li, Y., & Kang, J. S. (1993). Analysis of phonetics of the ideophonetic characters in modern Chinese. In: Chen, Y. (Ed.), *Information analysis of usage of characters in modern Chinese*. Shanghai: Shanghai Education Publisher. (in Chinese).

Li, W., Anderson, R. C., Nagy, W., & Zhang, H. (2002). Facets of metalinguistic awareness that contribute to Chinese literacy. In W. Li, J. S. Gaffney, & J. L. Packard (Eds.), *Chinese children's reading acquisition: Theoretical and pedagogical issues* (pp. 87-106). Boston: Kluwer Academic.

Liang, D. H. (1959). *The structure and development of Chinese writing*. Shanghai: Education Publisher.

Lin, Y.-H. (1989). *Autosegmental treatments of segmental process in Chinese phonology. Ph.D. dissertation*. University of Texas at Austin.

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

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

Lu, L., & Liu, M.-X. (1998). *Peabody vocabulary test—revised.* Taipei: Psychological Publishing.

Mann, V. A. (2000). Introduction to special issue on morphology and the acquisition of alphabetic writing systems. *Reading and Writing: An Interdisciplinary Journal*, *12*, 143-147.

McBride-Chang, C., Cho, J.-R., Liu, H., Wagner, R. K., Shu, H., Zhou, A., Cheuk, C. S.-M., & Muse, A. (2005). Changing models across cultures: Associations of phonological and morphological awareness to reading in Beijing, Hong Kong, Korea, and America. *Journal of Experimental Child Psychology*, *92*, 140-160.

McBride-Chang, C., & Ho, C. S.-H. (2000). Developmental issues in Chinese children's character recognition. *Journal of Educational Psychology*, *92*(1), 50-55.

McBride-Chang, C., & Kail, R. (2002). Cross-cultural similarities in the predictors of reading acquisition. *Child Development*, *73*, 1392-1407.

McBride-Chang, C., Shu, H., Ng, J. Y. W., Meng, X., & Penney, T. (2007). Morphological structure awareness, vocabulary, and reading. In R. K. Wagner, A. E. Muse & K. R. Tannenbaum (Eds.), *Vocabulary acquisition: Implications for reading comprehension* (pp. 104-122). New York, NY, US: Guilford Press.

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

McBride-Chang, C., Wagner, R. K., Muse, A., Chow, B. W. Y., & Shu, H. U. A. (2005). The role of morphological awareness in children's vocabulary acquisition in English. *Applied Psycholinguistics*, *26*, 415-435.

Metsala, J. L., & Walley, A. C. (1998). Spoken vocabulary growth and the segmental restructuring of lexical representations: Precursors to phonemic awareness and early reading ability. In J. L. Metsala (Ed.), *(1998). Word recognition in beginning literacy* (pp. 89-120). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Minister of Education, Taiwan. (1997). *Technical report of the word frequencies of occurrence in the Chinese dictionary*.

Nagy, W., & Anderson, R. C. (1998). Metalinguistic awareness and literacy acquisition in different language. In D. Wagner, R. Venezky, & B. Street (Eds.), *Literacy: An international handbook* (pp. 155-160). Boulder, CO: Westview.

Nation, K., & Snowling, M. J. (1998). Semantic processing and the development of word recognition skills: Evidence from children with reading comprehension difficulties. *Journal of Memory and Language*, *39*, 85-101.

Nation, K., & Snowling, M. J. (2004). Beyond phonological skills: Broader language skills contribute to the development of reading. *Journal of Research in Reading*, *27*, 342-356.

Newman, E. H., Tardif, T., Huang, J., & Shu, H. (2011). Phonemes matter: The role of phoneme-level awareness in emergent Chinese readers. *Journal of Experimental Child Psychology*, *108*(2), 242-259.

Oakhill, J., & Kyle, F. (2000). The relation between phonological awareness and working memory. *Journal of Experimental Child Psychology*, *75*, 152-164.

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

People's Republic of China, State Language and Letters Committee. (2008). *Table of*

frequent words in modern Chinese (Draft). Beijing: The Commercial Press.

Plaut, D. C., McClelland, J. L., Seidenberg, M. S., & Patterson, K. (1996). Understanding normal and impaired word reading: computational principles in quasi-regular domains. *Psychological Review*, *103*, 56-115.

Rayner, K., & Pollastsek, A. (1989). *The psychology of reading*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Schmalz, X., Marinus, E., & Castles, A. (2013). Phonological decoding or direct access? Regularity effects in lexical decisions of Grade 3 and 4 children. *The Quarterly Journal of Experimental Psychology*, *66*(2), 338-346.

Shibahara, N., Zorzi, M., Hill, M. P., Wydell, T., & Butterworth, B. (2003). Semantic effects in word naming: Evidence form English and Japanese kanji. *The Quarterly Journal of Experimental Psychology*, *56*, 263-286.

Shu, H. (2003). Chinese writing system and learning to read. *International Journal of Psychology*, *38*, 274-285.

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

Shu, H., Anderson, R. C., & Wu, N. (2000). Phonetic awareness: Knowledge of orthography-phonology relationships in the character acquisition of Chinese children. *Journal of Educational Psychology*, *92*, 56-62.

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

Shu, H., McBride-Chang, C., Wu, S., & Liu, H. (2006). Understanding Chinese developmental dyslexia: Morphological awareness as a core cognitive construct.

Journal of Educational Psychology, *98*, 122-133.

Shu, H., Meng, X., Chen, X., Luan, H., & Cao, F. (2005). The subtypes of developmental dyslexia in Chinese: Evidence from three cases. *Dyslexia*, *11*, 311-329.

Shu, H., Peng, H., & McBride-Chang, C. (2008). Phonological awareness in young Chinese children. *Developmental Science*, *11*(1), 171-181.

Shu, H., & Wu, N. (2006). Growth of orthography-phonology knowledge in the Chinese writing system. In P. Li, L. H. Tan, E. Bates, & O. J. L. Tzeng (Eds.), *The handbook of East Asian psycholinguistics* (Vol. 1, pp. 103-113). New York: Cambridge University Press.

Siok, W. T., & Fletcher, P. (2001). The role of phonological awareness and visual-orthographic skills in Chinese reading acquisition. *Developmental Psychology*, *37*, 886-899.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equations models. In S. Leinhart (Ed.), *Sociological methodology 1982* (pp. 290-312). San Francisco: Jossey-Bass.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, *21*, 360-406.

Stanovich, K. E., Cunningham, A. E., & Cramer, B. B. (1984). Assessing phonological awareness in kindergarten children: Issues of task comparability. *Journal of Experimental Child Psychology*, *38*, 175-190

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

Publisher.

Swank, L. K., & Catts, H. W. (1994). Phonological awareness and written word decoding. *Language, Speech, and Hearing Services in Schools*, *25*, 9-14.

Tong, X. L., & McBride-Chang, C. (2010). Developmental models of learning to read Chinese words. *Developmental Psychology*, *46*, 1662-1676.

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

Tong, X., McBride-Chang, C., Wong, A. M.-Y., Shu, H., Retisma, P., & Rispens, J. (2011). Longitudinal predictors of very early Chinese literacy acquisition. *Journal of Research in Reading*, *34*(3), 315-332.

Treiman, R., & Zukowski, A. (1991). Levels of phonological aware-ness. In S.A. Brady & D.P Shankweiler (Eds.), *Phonological processes in literacy: A tribute to Isabelle Y Liberman* (pp. 67- 83). Hillsdale, NJ: Erlbaum.

Tsai, M.-Y. (2009). *A longitudinal approach of the development of phonological, morphological awareness and its forecasting on literacy for first and second graders.* Master Thesis, National Tainan University, Taiwan. (in Chinese)

Tunmer, W. E., & M. L. Herriman. (1984). The development of metalinguistic awareness: A conceptual overview. In W. E. Tunmer, C. Pratt, & M. L. (Eds.), *Metalinguistic awareness in children: Theory, research, and implications*. Berlin: Springer Verlag.

Verhoeven, L., & Schreuder, R. (2011). Morpheme frequency effects in Dutch complex word reading: A developmental perspective. *Applied Psycholinguistics*, *32*(3), 483.

Walley, A. C., Metsala, J. L., & Garlock, V. M. (2003). Spoken vocabulary growth: Its

role in the development of phoneme awareness and early reading ability. *Reading and Writing*, *16*(1-2), 5-20.

Wan, Y.-Y. 萬雲英 (1991). 兒童學習漢字的心理特點與教學 (Psychological characteristics of children learning Chinese characters and teaching)。載於 *中國人中國心-發展與教學篇*，403-448。台北：遠流。

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

Wang, W. S.-Y. (1981). Language structure and optimal orthography. In O. J. L. Tzeng, & H. Singer (Eds.), *Perception of print: Reading research in experimental psychology* (pp. 223-236). Hillsdale, NJ: Lawrence Erlbaum.

Wu, N., Zhou, X., & Shu, H. (1999). Sublexical processing in reading Chinese: A development study. *Language & Cognitive Processes*, *14*, 503-524.

Yin, W., & Butterworth, B. (1992). Deep and surface dyslexia in Chinese. In H Chen & O. Tzeng (Eds.), *Language processing in Chinese* (pp. 349-366) Amsterdam: Elsevier Science Publishers.

Yin, W. G., & Weekes, B. S. (2003). Dyslexia in Chinese: Clues from cognitive neuropsychology. *Annals of Dyslexia*, *53*, 255 - 279.

Zhang, J., McBride-Chang, C., Tong, X., Wong, A. M. Y., Shu, H., & Fong, C. Y. C. (2012). Reading with meaning: the contributions of meaning-related variables at the word and subword levels to early Chinese reading comprehension. *Reading and Writing*, *25*(9), 2183-2203.

Zhou, Y. L., McBride-Chang, C., Fong, C. Y. C., Wong, T. T. Y., & Cheung, S. K.

(2012). A Comparison of Phonological Awareness, Lexical Compounding, and Homophone Training for Chinese Word Reading in Hong Kong Kindergartners. *Early Education & Development*, *23*(4), 475-492.

Zhou, L., Peng, G., Zheng, H. Y., Su, I. F., & Wang, W. S. (2013). Sub-lexical phonological and semantic processing of semantic radicals: A primed naming study. *Reading and Writing*, 26, 967-989.

Zhou, Y. G. (1980). *Phonological information of the phonetic radical of character consultant*. Changchun: Jilin People Publishing Company. (In Chinese).

Zhu, Y. P. (1987). Analysis of cuing functions of the phonetic in modern China. Unpublished manuscript, East China Normal University. (In Chinese).

Appendix A

Pilot Study

Some of the measures used in this study were newly created instead of being borrowed from the available tests in Taiwan; therefore, a pilot study was conducted to examine the appropriateness of these measures for Chinese third graders in Taiwan. These measures included: a) tone awareness, b) onset-rime awareness, c) homophone awareness, d) phonetic radical awareness, e) semantic radical awareness and f) two-character reading. Specifically, this pilot study was aimed to evaluate the internal consistency (Cronbach's Alpha), skewness, and clarity of instructions of the above measures, and then to select the items that could significantly discriminate better performers from poorer performers. The detailed description of each measure is given below.

Methods

Participants

A total of twenty-eight monolingual Chinese-speaking third-graders recruited from an elementary school in Zhonghe, New Taipei City, Taiwan served as the participants of the pilot study. One child did not receive the tone awareness task, onset-rime awareness task and homophone awareness task due to his illness on the testing day, leaving 27 children taking these measures. All of the children were individually tested in a quiet place in January of the school year (i.e., the end of fall semester). Based on the classroom teachers' report, none of the children had a history of emotional, articulatory and neurological disorders. In addition, these children had already received formal reading education for two and half years, including 10-week instructions of *Zhuyin Fuhao*. According to the Chinese textbooks of grade 1 to grade 3 employed in Taiwan, the basics of the phonetic and semantic radicals are taught in school; thus,

the participants should have some fundamental skills of completing the tasks measuring their awareness of phonetic and semantic radicals.

Tasks and Procedures

Tone Awareness Task

There were a total of 30 trials in this task. On each trial, the children were presented with a target syllable (e.g., shu1) followed by three alternative syllables (e.g., /hu1/, /fu2/, /su4/), from which they were required to choose the one (e.g., /hu1/) that sounded more similar to the target in terms of the tone. One of the three alternative syllables bore the same tone as the target syllable. In one half of the trials, the alternative syllables shared the same rime with the target syllable (e.g., /shu1/: /hu1/, /fu2/, /su4/). In the other half, the alternative syllables did not share the rime with the target syllable (e.g., /gua1/: /dian1/, /bao3/, /pi4/). In addition, various levels of item difficulty were manipulated by varying the manner of articulation of the consonant in the alternative syllables. In a simple trial, the onsets of the three alternative syllables shared the same manner of articulation with that of the target syllable (e.g., fricative, stop, affricate, and sonorant), such as /**sh**u1/: /**h**u1/, /**f**u2/,/**s**u4/. In a more difficult trial, the onsets of the three alternative syllables had different manners of articulation from that of the target syllable, such as /**g**en1/: /**m**en1/, /**f**en3/, /**ch**en4/.The positions of the correct answer were counterbalanced across the 30 trials. The children were told that they would hear a target syllable twice followed by three alternative syllables and see three printed numbers, 1, 2 and 3 on the answer sheet that corresponded respectively to the three alternative syllables. The children had to pay special attention to the tone of the target syllable and circle the number representing the alternative syllable that had the same tone with the target syllable.

Three practice trials were given before the test trials to make sure that the children understood the task. The feedback on the correctness of the response was given to the children in

the practice trial. If the children made an error in the practice trial, they were given the correct answer and told why it was correct. During the test trials, no feedback was provided to the children, and they were asked to try their best to do the task by their own. One point was given for each correct response in the test trials (Max = 30). The instructions for this task were given below:

> "I am going to say a word to you followed by three choice words and you will see three numbers, 1, 2 and 3 on this sheet. The three numbers represent the three choice words I just read. One of the three choice words has the same tone with the word I just said. I want you to listen to the word and the three choice words carefully, and circle the number representing the choice word that has the same tone with the word I just said. Now listen, /shu1/. Which of the three words, /hu1/, /fu2/, /su4/ (pointing to the numbers 1, 2, and 3, respectively) do you think shares the same tone with /shu1/? Is it /hu1/, /fu2/, or /su4/ (pointing to the numbers 1, 2, and 3, respectively)? Please circle the number for me!"

Onset-rime Awareness Task

In this study, children's phonological awareness was measured at the onset-rime level but not at the syllable level because onset-rime awareness was found in previous studies (e.g., Newman, Tardif, Huang, & Shu, 2011) to better predict elementary school children's reading ability than syllable awareness. The onset-rime awareness task was administered in an "oddity" format, where the children were required to identify out of three spoken syllables the "odd" one that had a different onset or rime from the other two syllables. There were a total of 30 trials in this task. The information on the percentage at which a phonetic radical provides the onset or rime cue for its host phonogram was used to determine the number of onset and rime trials. According to Li and Kang (1993), about 62.11% and 70.05% of phonograms share the same

onset and rime, respectively, with their phonetic radical irrespective of the tone. The 30 trials were thus prorated based on the percentage information in question, leading to 14 onset trials (e.g., /mao2/, /mei2/, /**n**iu2/) and 16 rime trials (e.g., /ta1/, /gu**ai**1/, /sha1/). Hu and Catts (1998) found that the trial containing three syllables with different tones (e.g., /po**2/**, /da**4/**, /ma**3/**) in the onset-rime awareness task posed great difficulty on children. Given this, the trial with different tonal syllables may not purely measure children's onset-rime awareness independent of the effect of tones. To avoid this potential confound caused by different tones, all of the syllables in a triad were assigned the same tone in this task. The three syllables were presented as a set twice to the children, accompanied by three printed numbers, 1, 2 and 3, respectively, on the answer sheet. The positions of the correct answers were counterbalanced across the 30 trials. The children had to pay special attention to the beginning or ending sounds of the three spoken words depending on the trial type (i.e., onset or rime trial). The children's job was to circle the number representing the spoken word that had a different beginning or ending sound.

Three practice trials were given before the test trials to make sure that the children understood the task. The feedback on the correctness of the response was given to the children in the practice trial. If the children made an error in the practice trial, they were given the correct answer and told why it was correct. During the test trials, no feedback was provided to the children, and they were asked to try their best to complete the task on their own. One point was given for each correct response (max = 30). The instructions for this task are given below:

> "I am going to read three spoken words for you, and you will see three numbers, 1, 2 and 3 here on this sheet. The three numbers represent the three spoken words I just read. One spoken word has a different beginning/ending sound from the other two. Please listen carefully to the beginning/ending sounds of each word and circle the number representing

the spoken word that has a different beginning/ending sound. Now, listen! /la1/, /hei1/, /he1/ (pointing to the numbers 1, 2, and 3, respectively). One of the spoken words has a different beginning sound from the other two. Can you tell me which one? Is it /la1/, /hei1/, or /he1/ (pointing to the numbers 1, 2, and 3, respectively)? Please circle the number for me!"

Phonetic Radical Awareness Task

The phonetic radical awareness task was similar to that used by Ho, Ng and Ng (2003). In this task, the children were required to read 25 pseudo-phonograms. A pseudo-phonogram was created by combining a phonetic radical (e.g., 馬 /ma3/) and a semantic radical (e.g., 言) in their legal positions, but the combination (e.g., 誗 /ma3/) did not comprise a real character in Chinese. The only cue to the pronunciation of the pseudo-phonogram was through its phonetic radical. According to Ho, Ng and Ng (2003), the pseudo-phonogram reading task can be employed to measure children's overall knowledge of the function and sound value of the phonetic radical, and their ability to use direct derivation and analogy strategies to pronounce a novel character.

Two types of phonetic radicals were selected to make the pseudo-phonograms for this task: one type was the free phonetic radical, which can stand alone as a real character; the other type was the bound phonetic radical, which cannot appear alone as a real character but must be attached to a semantic radical. The free phonetic radical directly provided the pronunciation of a pseudo-phonogram that contains it (e.g., 誗 /ma3/ shown above). On the other hand, a pseudo-phonogram with a bound phonetic radical must be pronounced by analogy with other characters containing the same bound phonetic radical. For example, the pseudo-phonogram 鄜 /fu4/ shares the same bound phonetic radical, 畐, with real characters, such as 副 /fu4/.

For this task, item difficulty was manipulated by including phonetic radicals with various

frequencies at which they occur in different Chinese characters. Zhou's (1980) book, *Phonological Information of the Phonetic Radical of Character Consultant*, served as the basis for choosing the phonetic radical. A simple trial consisted of a pseudo-phonogram whose phonetic radical (e.g., 馬) can be used to generate eight or more characters. A more difficult trial consisted of a pseudo-phonogram whose phonetic radical can be used to generate five or less real characters (e.g., 受). The boundness and frequency of the phonetic radical crossed orthogonally with each other, yielding four types of stimuli: free/high frequent (7 trials), free/low frequent (6 trials), bound/high frequency (6 trials), and bound/low frequency (6 trials). One point was given for each correct response (max = 25). The instructions for this task are given below:

> "Here are some funny characters that you have never seen before. They are all readable. Now, I want you to try your best to read each character for me. If you don't know how to read a character, just skip it. I cannot help you!"

Homophone Awareness Task

In this task, the children compared and distinguished homophones embedded in familiar spoken words. Like the onset-rime awareness task, the homophone awareness task was also administered in the "oddity" format. There were a total of 25 trials in this task. On each trial, the children were orally presented with three familiar bimorphemic words, all of which shared a homophone. Given that Chinese homophones are more easily distinguished in the print form (i.e., characters) than in the oral form, the children may make use of their character knowledge to discriminate the spoken homophones (Hu, 2013). To avoid this possibility, the homophones to be compared in this task were carefully selected so that their corresponding characters were unknown to most third graders in Taiwan based on three school teachers' judgment. This would ensure that the children judged the meanings of the spoken homophone solely based on their oral

language experience rather than their print experience. In each trial, two words shared a semantically similar homophone, which was not shared by the third word (i.e., the odd word). The three words were presented as a set twice to the children, accompanied by three printed numbers, 1, 2 and 3, respectively, on the answer sheet. The children were required to circle the number representing the odd word from the three words. The positions of the odd words were counterbalanced across the 25 test trials.

In this task, two types of trials were included. In the first type (13 trials), the position of the homophone of the odd word is the same as those of the homophones of the other two words, such as 裝**飾** /zhuang1**shi4**/ 'decorate', 解**釋** /jie3**shi4**/ 'explain' and 修**飾** /xiu1**shi4**/ 'modify'. In the second type (12 trials), the position of the homophone of the odd word was different from that of the homophone(s) of either or both of the other two words, such as 彎**腰** /wan1**yao1**/ 'bend', **邀**請 /**yao1**qing3/ 'invite' and 受**邀** /shou4**yao1**/ 'being invited'.

The test trials were preceded by three practice trials, during which the experimenter explained to the children how to do this task and provided feedback on the correctness of the response when necessary. There was no feedback given on the test trials. One point was given for each correct response (max = 25). The instructions used for this task are given below:

> "I am going to read three spoken words for you, and you will see three numbers, 1, 2 and 3 here on this sheet. The three numbers represent the spoken words I just read. The three words share a homophone. The meaning of one homophone was different from those of the other two. I want you to listen carefully to the three spoken words, and circle the number representing the word that contained a semantically different homophone. Now, listen! 公雞 /gong1ji1/ 'rooster', 小雞 /xiao3ji1/ 'chick' and 飛機 /fei1ji1/ 'airplane' (pointing to the numbers 1, 2, and 3, respectively) all have /ji1/. Which word do you think contains /ji1/

that has a different meaning from the other two? Is it 公雞 /gong1ji1/ ‘rooster’, 小雞 /xiao3ji1/ ‘chick’ or 飛機 /fei1ji1/ ‘airplane’ (pointing to the numbers 1, 2, and 3, respectively)? Please circle the number for me!”

Semantic Radical Awareness Task

The format of the semantic radical awareness task was similar to that adopted in Shu and Anderson’s (1997) study except for the way to present the test stimuli (see below). There were a total of 25 trials in this task. For each trial, the children were orally provided with a familiar spoken word (e.g., 瞳孔 /tong2kong3/ ‘pupil’). One constituent morpheme of the spoken word (e.g., 瞳 /tong2/) was unknown in print to the child based on three school teachers’ judgment and served as the target morpheme. The semantic radical of the character representing the target morpheme contributed to the meaning of that morpheme (i.e., transparent semantic radical). Since the children were expected to select the character based on its semantic radical, the character with an opaque semantic radical (which provided no semantic cues) was not used in this task. Followed by the oral presentation of the spoken word was the visual presentation of three unknown printed characters (e.g., 僮, 瞳, 潼), one of which represented the target morpheme. The three characters shared the same phonetic radical (e.g., 童 /tong2/) and thus pronounced the same, but had a different semantic radical (e.g., 目 in 瞳, 月 in 膧, and 氵 in 潼). The semantic radical (e.g., 目 ‘eye-related’) of the character representing the target morpheme (e.g., 瞳) specified the semantic category of the spoken word (e.g., 瞳孔 /tong2kong3/ ‘pupil’). The semantic radicals of the other two characters (e.g., 僮 and 潼) denoted different semantic categories (e.g., 亻 is ‘human-related’; 氵 is ‘water-related’) from the semantic radical of the character representing the target morpheme. The children were required to circle the character from the three printed characters that represented the target

morpheme. The positions of the correct answers were counterbalanced across the 10 trials. A comparable English example would be to orally present a phrase (e.g., *one cent*) to the children, followed by the visual presentation of three printed words (e.g., *cent*, *sent* and *scent*) and ask the children to circle the correct printed word to represent the target word in the phrase.

The way the test words were presented in the present study (i.e., oral presentation) was different from that in Shu and Anderson's (1997) study, where the test words were presented in print. In their study, the character of the target morpheme was represented by its *Pinyin* (i.e., the phonetic alphabet used in China), and the children were asked to select an appropriate character to replace the *Pinyin*. The present study did not visually present the test words and did not use *Zhuyin Fuhao* to represent the character of the target morpheme because the individual difference in decoding *Zhuyin Fuhao* may confound the results.

For this task, item difficulty was manipulated by including words varying in conceptual abstractness. A simple trial consisted of a concrete word that is easier to illustrate with pictures (e.g., 瞳孔 /tong2kong3/ 'pupil'), whereas a more difficult trial consisted of an abstract word that is harder to depict with pictures (e.g., 謠言 /yao2yan2/ 'rumor'). There were 13 simple trials and 12 difficult trials in this task. The test trials were preceded by three practice trials, where the experimenter made sure that the children understood the task. One point was given for each correct response to the test trial (max = 25). The instructions for this task are given below:

> "I am going to read a word for you, and you will see three printed characters on this sheet. One of the three printed characters represents a constituent sound of the word I just read, and I want you to circle that character for me. Now, listen! Which of the three printed characters represents 狗 /gou3/ 'dog' in 小狗 /xiao3gou3/ 'puppy'? Please circle the character for me!"

Two-character Reading Task

Because there is no standardized two-character reading test in Taiwan, a new two-character test was invented for the present study. In this test, the children read 200 two-character words selected from the Chinese textbooks of grade 1 to grade 6, with approximately 33-34 words per grade. The test words were all composed of two morphemes. In Chinese, most morphemes correspond to one syllable and one character, such as 貓 /mao1/ 'cat'; however, Chinese has a few disyllabic morphemes which are represented by two characters, such as 葡萄 /pu2tao2/ 'grape'. Given that the present study was to see whether morphological construction (which involved the decomposition of words into constituent morphemes and the insight into the morphological structure in words) would help children analyze the internal structure of a bimorphemic word in reading, two-character words that were composed of only one disyllabic morpheme (which cannot be further analyzed into constituent morphemes) were excluded in this task. The average frequency of occurrence for the 200 two-characters was 76.65 (Range = 1 - 2613) based on the *Technical Report of the Word Frequencies of Occurrence in the Chinese Dictionary* published by the Ministry of Education (1997) in Taiwan.

The 200 two-character words were printed in Kaiu Font 30 on a sheet of A4 size paper. These words were displayed in 20 rows of 10 items each and were arranged from high to low frequency of occurrence. The children were required to read all of the 200 words one by one. To avoid potential frustration and fatigue the child may face during the test, the author followed the stop criterion adopted in Huang's (2004) *Chinese Graded Character Recognition Test* by stopping the test right after 20 consecutive errors were made. One point was given for each two-character word correctly read (max = 200). The instructions for this task are given below:

"Here are some two-character words, and I want to know how many words you know.

Please start to read the words one by one from the first word until I ask you to stop! If you don't know how to read a word, just skip it. I cannot help you."

Results

Descriptive statistics of the six measures with the original item pool are presented in Table A-1. For the two-character reading task, only the data of children who did not reach the 20-error stop criterion and thus did all the way to the last item were analyzed. As a result, only 21 children's data on the two-character reading task were analyzed. As shown in Table A-1, the skewness indices of the tone awareness task and onset-rime awareness task were negative and significantly different from zero (all *p*s < .05), suggesting a potential ceiling effect on these two measures. On the other hand, the skewness indices of the remaining measures were not significantly different from zero and thus the distributions of the scores in these measures were very close to normal.

Table A-1

Descriptive statistics of for the six original measures

	N	Mean	SD	Range	Skewness	Cronbach's Alpha
Tone Awareness (Max = 30)	27	27.22	4.35	13-30	-1.84 ($p < .05$)	.90
Onset-rime Awareness (Max = 30)	27	24.67	5.28	10-30	-1.36 ($p < .05$)	.89
Phonetic Radical Awareness (Max = 25)	28	14.39	5.81	3-22	-.31 ($p > .05$)	.88
Homophone Awareness (Max = 25)	27	16.26	4.01	7-24	-.12 ($p > .05$)	.75
Semantic Radical Awareness (Max = 25)	28	20.79	3.25	16-25	-.14 ($p > .05$)	.75
Two-character Reading (Max = 200)	21	127.90	23.66	94-179	.41 ($p > .05$)	.97

Item Analysis

An extreme-group-comparison approach to item analysis was employed in the pilot study to select the items. Specifically, the participants whose score obtained from the original item pool was on the two extremes (higher group: upper 27%; lower group: lower 27%) on the score scale were compared on their performances on each item. The item that yielded significantly different scores ($p < .05$) between the higher and lower groups was considered to have a high power of discrimination and would be retained. Through this approach, 8 items in the tone awareness task, 19 items in the onset-rime awareness task, 9 items in the phonetic radical awareness task, 14

items in the homophone awareness task, 15 items on the semantic radical awareness task and 157 words in the two-character reading task could not significantly discriminate the higher group from the lower group and thus were excluded from the original item pool. Descriptive statistics of the six measures with significantly discriminating items were given in Table A-2. As shown in Table A-2, the skewness of the tone awareness task was still significantly different from zero even after the items with high discriminating power were retained, suggesting a ceiling effect; thus, the tone awareness task was dropped from the current study. On the contrary, the distribution of the adjusted onset-rime awareness task was close to normal since its skewness was not significantly different from zero after the discriminating items were kept. The distributions of the remaining four tasks (i.e., phonetic radical awareness, homophone awareness, semantic radical awareness and two-character reading) were all close to normal after the items with high discrimination power were selected, as evidenced by their insignificant skewness indices (all ps > .05). Regarding the internal consistency, all of the adjusted tasks had an acceptable Cronbach's Alpha (i.e., above .70) based on Kline's (1999) criterion, indicating that the selected items are all reliable and measure the same construct.

Table A-2

Descriptive statistics of for the six adjusted measures

	N	Mean	SD	Range	Skewness	Cronbach's Alpha
Tone Awareness (Max = 22)	27	19.56	3.95	7-22	-1.81 ($p < .05$)	.90
Onset-rime Awareness (Max = 11)	27	7.74	3.03	2-11	-.67 ($p > .05$)	.84
Phonetic Radical Awareness (Max = 16)	28	9.03	4.76	0-16	-.14 ($p > .05$)	.89
Homophone Awareness (Max = 11)	27	6.19	2.77	2-11	.06 ($p > .05$)	.76
Semantic Radical Awareness (Max = 10)	28	6.68	2.54	2-10	-.17 ($p > .05$)	.73
Two-character Reading (Max = 43)	21	23.71	11.91	6-43	.16 ($p > .05$)	.96

In general, the results of the pilot study revealed that the instruction for each of the six tasks was clear enough for the third-graders and did not cause any misunderstanding. Through an item analysis, the tone awareness task was dropped from the current study due to the ceiling effect. The other five measures (i.e., onset-rime awareness, homophone awareness, phonetic radical awareness, semantic radical awareness and two-character reading) all had close-to-normal distribution after item analysis had been done. In addition, the five measures also proved to be reliable for third-graders in Taiwan. Therefore, the test stimuli and the test format of the five adjusted measures were retained for the actual study.

Appendix B

Test Stimuli for the Onset-rime Awareness Task

Onset Awareness

Practice trials
1. /la1/, /hei1/, /he1/
2. /mi4/, /mu4/, /zan4/
3. /tao1/, /chai1/, /tan1/

Test trials
1. /hai3/, /shang3/, /hu3/
2. /zao4/, /tu4/, /tan4/
3. /pu3/, /pao3/, /rang3/
4. /guo3/, /kao3/, /gu3/
5. /san1/, /sun1/, /xiung1/
6. /fa2/, /can2/, /fu2/

Rime Awareness

Practice trials
1. /can4/, /man4/, /shu4/
2. /ti1/, /zhao1/, /pi1/
3. /chou2/, /xu2/, /ju2/

Test trials
1. /dian4/, /xie4/, /mie4/
2. /fang2/, /meng2/, /kang2/
3. /tao1/, /kan1/, /fan1/
4. /mai3/, /cai34/, /dao3/
5. /ko4/, /nen4/, /shen4/

Appendix C

Test Stimuli for the Homophone Awareness Task

Practice trials

1. 飛機、公雞、小雞
2. 書包、舒服、書架
3. 天空、白天、添加

Test trials

1. 掩護、遮掩、敷衍
2. 探險、顯現、危險
3. 超人、超過、鈔票
4. 殘酷、短褲、冷酷
5. 裝飾、解釋、修飾
6. 輔導、輔助、撫摸
7. 輸贏、蒼蠅、蚊蠅
8. 迷惑、獲得、誘惑
9. 彎腰、邀請、受邀
10. 耽擱、承擔、耽誤
11. 歸還、規則、規定

Appendix D

Test Stimuli for the Semantic Radical Awareness Task

Practice trials

1. 小狗：狗、枸 、岣
2. 跳繩：眺、跳 、絩
3. 眼睛：精、菁 、睛

Test trials

1. 燦爛：璨、潺、燦
2. 飢餓：虮、飢、肌
3. 蠟燭：燭、蠋、躅
4. 草莓：莓、霉、梅
5. 吩咐：氛、玢、吩
6. 轎車：嶠、撟、轎
7. 耳聾：瀧、嚨、聾
8. 謠言：瑤、傜、謠
9. 英俊：俊、駿、竣
10. 瞳孔：僮、瞳、潼

Appendix E

Test Stimuli for the Phonetic Radical Awareness Task

1	2	3	4	5
糀	豔	唌	鄙	譵

6	7	8	9	10
襙	徭	縐	玻	戩

11	12	13	14	15
秣	炻	隋	旖	瑄

16
刈

Appendix F

Test Stimuli for the Morphological Construction Task[2]

一個外國朋友從美國來，我們說他是美國人，如果從英國來我們說他是英國人，
如果從印度來，我們說他是什麼？（三個字）_____（若說不出或說錯，需糾正）
如果從肯亞來，我們說他是什麼？（三個字）_____（若說不出或說錯，需糾正）。
一個學校最大的人，我們說他是校長，一個班最大的人，我們說他是班長，
一個商店最大的人我們說他是什麼？（兩個字）_____（若說不出或說錯，需糾正，例如學生若說成老闆，告訴他「要照我說的話說，我剛剛說校長和班長，你要學我造詞，所以一個商店最大的人是店長」；若說對，則說「很好，你知道要學我說的方式造詞，很多人都沒照我的方式造詞，把一個商店最大的人說成是老闆」）。
一個城市最大的人我們說他是什麼？（兩個字）_____（若說不出或說錯，需糾正）
好，接下來我要給你新的題目做，你要仔細聽，照我說的方式來回答我的問題。**強調粗體字。**

1. 我們希望環境多一些綠色植物，我們會說我們要把環境「**綠化**」，如果我們希望我們的環境多一些香噴噴的東西，我們會說要把環境怎麼樣？（兩個字）_____（香化）。
2. 小明的爸爸在公司是處理技術的，我們說小明的爸爸是「**技術員**」。大華的爸爸在公司是處理文件的，我們說大華的爸爸是什麼？（三個字）_____（文件員）。
3. 台北市經營的公車叫「**市營公車**」，如果你們學校也要經營的公車，這種公車叫什麼？(四個字)_____（校營公車）。
4. 小明很瘦，我們說他「**瘦巴巴**」，大華很醜，我們說他怎麼樣？（三個字）_____(醜巴巴)。
5. 一個電視節目很好看，我們說這個電視節目很有「**可看性**」，一個遊戲很好玩，我們說這個遊戲很有什麼？（三個字）_____(可玩性)。
6. 小明常常很糊塗，我們說他「**糊里糊塗**」，大華常常很自私，我們說他怎麼樣？(四個字)_____(自里自私)。
7. 如果我們想知道一個東西溫不溫暖，我們會說要去測量這個東西的「**溫度**」，如果我們想知道一個東西吃起來會不會太脆，我們會說要去測量這個東西的什麼？（兩個字）_____(脆度)。
8. 一個照顧兒童的地方，我們叫它「**托兒所**」，一個照顧小鳥的地方，我們叫它什麼？（三個字）_____(托鳥所)。
9. 我們要調查一個國家有多少人，我們說我們要調查這個國家的「**人口**」，如果我們要調

[2] The test stimuli for the morphological awareness construction task were provided by Dr. Chieh-Fang Hu from her study (Hu, 2013).

查一個動物園養了多少猴子，我們說要調查這個動物園的什麼？（兩個字）_____(猴口)。

10. 一個人不喜歡自己一個人讀書，我們說這個人必須找一個人「**陪讀**」，如果一個人不喜歡自己一個人煮飯，我們說這個人必須找一個人怎麼樣？（兩個字） _____(陪煮)。
11. 我們希望環境多一些綠色植物，我們會說我們要把環境「**綠化**」，如果我們希望我們的環境變得比較明亮，我們會說要把環境怎麼樣？（兩個字） _____(明化、亮化，圈出正確答案)。
12. 小明的爸爸在公司是處理技術的，我們說小明的爸爸是「**技術員**」。小美的爸爸在公司是處理電腦的，我們說小美的爸爸是什麼？（三個字） _____(電腦員)。
13. 台北市經營的公車叫「**市營公車**」，如果你們班也要經營的公車，這種公車叫什麼？(四個字) _____(班營公車)。
14. 小明很瘦，我們說他「**瘦巴巴**」，小美很輕，我們說他怎麼樣？（三個字）_____(輕巴巴)。
15. 一個電視節目很好看，我們說這個電視節目很有「**可看性**」，一杯飲料很好喝，我們說這杯飲料很有什麼？（三個字）_____(可喝性)。
16. 小明常常很糊塗，我們說他「**糊里糊塗**」，小美常常很懶惰，我們說他怎麼樣？(四個字) _____(懶里懶惰)。
17. 我們想知道一個東西溫不溫暖，我們會說要去測量這個東西的「**溫度**」，如果我們想知道一個人會不會太肥，我們會說要去測量這個人的什麼？（兩個字） _____(肥度)。
18. 一個照顧兒童的地方，我們叫它「**托兒所**」，一個照顧小豬的地方，我們叫它什麼？（三個字） _____(拖豬所)。
19. 我們要調查一個國家有多少人，我們說我們要調查這個國家的「**人口**」，如果我們要調查一個池塘養了多少金魚，我們說要調查這個池塘的什麼？(兩個字）_____(魚口)。
20. 一個人不喜歡自己一個人讀書，我們說這個人必須找一個人「**陪讀**」，如果一個人不喜歡自己一個人騎車，我們說這個人必須找一個人怎麼樣？（兩個字） _____(陪騎)。

Appendix G

Test Stimuli for the Two-character Reading Task

1. 溫馨
2. 挖掘
3. 實踐
4. 技藝
5. 聚集
6. 繁殖
7. 蛻變
8. 別墅
9. 謹慎
10. 沮喪
11. 沸騰
12. 警惕
13. 敏銳
14. 粗糙
15. 捐贈
16. 防禦
17. 瀰漫
18. 痊癒
19. 奔馳
20. 壓軸
21. 洩漏
22. 攤販
23. 輪廓
24. 咀嚼
25. 佳餚
26. 蔚藍
27. 新穎
28. 切磋
29. 摧殘
30. 釀酒
31. 繁衍
32. 堅韌
33. 海藻
34. 僵持
35. 蒙蔽
36. 眼眶
37. 伎倆
38. 翱翔
39. 蠻荒
40. 豁然
41. 肆意
42. 眷顧
43. 忌憚

Appendix H

Results for Metalinguistic Awareness Predicting Radical Awareness

Table H-1

Summary of regression analysis for onset-rime awareness predicting phonetic radical awareness

Variable	*B*	*SE B*	β
Onset-rime Awareness	.15	.07	.21*

Note. $R^2 = .04$ ($p < .05$)

* $p < .05$

Table H-2

Summary of regression analysis for homophone awareness predicting semantic radical awareness

Variable	*B*	*SE B*	β
Homophone Awareness	.18	.06	.28**

Note. $R^2 = .08$ ($p < .01$)

** $p < .01$

Table H-3

Summary of regression analysis for morphological construction predicting semantic radical awareness

Variable	*B*	*SE B*	β
Morphological Construction	.09	.31	.31**

Note. $R^2 = .10$ ($p < .01$)

** $p < .01$

Appendix I

Results for Metalinguistic Awareness Predicting Chinese Reading

Table I-1

Summary of regression analysis for onset-rime awareness predicting single- and two-character reading

Steps	Variables	Single-character Reading			Two-character Reading		
		B	*SE B*	β	*B*	*SE B*	β
1	Age	.02	.48	.00	-.02	.19	-.01
	Vocabulary	1.40	.19	.59***	.70	.07	.69***
2	Age	-.09	.48	-.01	-.06	.19	-.02
	Vocabulary	1.36	.18	.58***	.68	.07	.67***
	Onset-Rime_A	1.46	.72	.16*	.46	.28	.12

Note. 1. Onset-Rime_A = onset-rime awareness

2. For single-character reading, R^2 = .35 (p < .001) in Step 1; ΔR^2 = .03 (p < .05) in Step 2.

3. For two-character reading, R^2 = .47 (p < .001) in Step 1; ΔR^2 = .01 (p > .05) in Step 2.

* p < .05

*** p < .001

Table I-2

Summary of regression analysis for homophone awareness predicting single- and two-character reading

Steps	Variables	Single-character Reading			Two-character Reading		
		B	*SE B*	β	*B*	*SE B*	β
1	Age	.02	.48	.00	-.02	.19	-.01
	Vocabulary	1.40	.19	.59***	.70	.07	.69***
2	Age	-.08	.47	-.01	-.07	.18	-.03
	Vocabulary	1.10	.20	.47***	.57	.08	.56***
	Homophone_A	2.98	.96	.27**	1.34	.37	.28***

Note. 1. Homophone_A = homophone awareness

2. For single-character reading, R^2 = .35 (p < .001) in Step 1; ΔR^2 = .06 (p < .01) in Step 2.

3. For two-character reading, R^2 = .47 (p < .001) in Step 1; ΔR^2 = .06 (p < .001) in Step 2.

** p < .01

*** p < .001

Table I-3

Summary of regression analysis for morphological construction predicting single- and two-character reading

Steps	Variables	Single-character Reading			Two-character Reading		
		B	*SE B*	β	*B*	*SE B*	β
1	Age	.02	.48	.00	-.02	.19	-.01
	Vocabulary	1.40	.19	.59***	.70	.07	.69***
2	Age	-.24	.46	-.04	-.09	.19	-.04
	Vocabulary	1.04	.20	.44***	.60	.08	.59***
	Morphological _C	1.60	.42	.32***	.43	.17	.20*

Note. 1. Morphological_C = morphological construction

2. For single-character reading, $R^2 = .35$ ($p < .001$) in Step 1; $\Delta R^2 = .08$ ($p < .001$) in Step 2

3. For two-character reading, $R^2 = .47$ ($p < .001$) in Step 1; $\Delta R^2 = .03$ ($p < .05$) in Step 2

* $p < .05$

*** $p < .001$

Appendix J

Results for Radical Awareness Predicting Chinese Reading Over and Above Metalinguistic Awareness

Table J-1

Summary of regression analysis for phonetic radical awareness predicting single-character reading with age, vocabulary knowledge and onset-rime awareness controlled

Steps	Variables	Single-character Reading		
		B	*SE B*	β
1	Age	.02	.48	.00
	Vocabulary	1.40	.19	.59***
2	Age	-.09	.48	-.01
	Vocabulary	1.36	.18	.58***
	Onset-Rime_A	1.46	.72	.16*
3	Age	-.35	.43	-.06
	Vocabulary	1.23	.17	.52***
	Onset-Rime_A	.87	.66	.10
	Phonetic_A	2.51	.49	.37***

Note. 1. Onset-Rime_A = onset-rime awareness; Phonetic_A = phonetic radical awareness

2. $R^2 = .35$ ($p < .001$) in Step 1; $\Delta R^2 = .03$ ($p < .05$) in Step 2; $\Delta R^2 = .12$ ($p < .001$) in Step 3

* $p < .05$

*** $p < .001$

Table J-2

Summary of regression analysis for semantic radical awareness predicting single- and two-character reading with age, vocabulary knowledge and homophone awareness controlled

Steps	Variables	Single-character Reading			Two-character Reading		
		B	*SE B*	β	*B*	*SE B*	β
1	Age	.02	.48	.00	-.02	.19	-.01
	Vocabulary	1.40	.19	.59***	.70	.07	.69***
2	Age	-.08	.47	-.01	-.07	.18	-.03
	Vocabulary	1.10	.20	.47***	.57	.08	.56***
	Homophone_A	2.98	.96	.27*	1.34	.37	.28***
3	Age	-.12	.46	-.02	-.09	.17	-.04
	Vocabulary	.93	.22	.40***	.43	.08	.43***
	Homophone_A	2.90	.95	.26**	1.28	.35	.27***
	Semantic_A	2.71	1.52	.16	2.05	.56	.27***

Note. 1. Homophone_A = homophone awareness; Semantic_A = semantic radical awareness

2. For single-character reading, $R^2 = .35$ ($p < .001$) in Step 1; $\Delta R^2 = .06$ ($p < .01$) in Step 2. $\Delta R^2 = .02$ ($p > .05$) in Step 3.

3. For two-character reading, $R^2 = .47$ ($p < .001$) in Step 1; $\Delta R^2 = .06$ ($p < .001$) in Step 2. $\Delta R^2 = .05$ ($p < .001$) in Step 3.

* $p < .05$

** $p < .01$

*** $p < .001$

Table J-3

Summary of regression analysis for semantic radical awareness predicting single- and two-character reading with age, vocabulary knowledge and morphological construction controlled

Steps	Variables	Single-character Reading			Two-character Reading		
		B	*SE B*	β	*B*	*SE B*	β
1	Age	.02	.48	.00	-.02	.19	-.01
	Vocabulary	1.40	.19	.59***	.70	.07	.69***
2	Age	-.24	.46	-.04	-.09	.19	-.04
	Vocabulary	1.04	.20	.44***	.60	.08	.59***
	Morphological _C	1.60	.42	.32***	.43	.17	.20*
3	Age	-.27	.46	-.04	-.12	.18	-.04
	Vocabulary	.89	.22	.38***	.47	.08	.47***
	Morphological _C	1.54	.42	.31***	.39	.16	.18*
	Semantic_A	2.49	1.49	.14	2.03	.58	.27**

Note. 1. Morphological_C = morphological construction; Semantic_A = semantic radical awareness

2. For single-character reading, $R^2 = .35$ ($p < .001$) in Step 1; $\Delta R^2 = .08$ ($p < .001$) in Step 2 $\Delta R^2 = .02$ ($p > .05$) in Step 3.

3. For two-character reading, $R^2 = .47$ ($p < .001$) in Step 1; $\Delta R^2 = .03$ ($p < .05$) in Step 2 $\Delta R^2 = .05$ ($p < .01$) in Step 3.

* $p < .05$

** $p < .01$

*** $p < .001$

Appendix K

Unique Variance in Single-character and Two-character Reading Explained by Morphological Awareness

Table K-1

Unique variance (R^2 change) in single-character and two-character reading accounted for by morphological construction with age, vocabulary knowledge, and homophone awareness controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Homophone_A	.41	.06**	.53	.06***
3	Morphological_C	.50	.06**	.55	.02*

Note. Homophone_A = homophone awareness; Morphological_C = morphological construction

* $p < .05$

** $p < .01$

*** $p < .001$

Table K-2

Unique variance (R^2 change) in single-character and two-character reading accounted for by homophone awareness with age, vocabulary knowledge, and morphological construction controlled

Steps	Variables	Single-character Reading		Two-character Reading	
		R^2	ΔR^2	R^2	ΔR^2
1	Age Vocabulary	.35	.35***	.47	.47***
2	Morphological_C	.43	.08***	.50	.03*
3	Homophone_A	.47	.04**	.55	.05**

Note. Homophone_A = homophone awareness; Morphological_C = morphological construction

* $p < .05$

** $p < .01$

*** $p < .001$

Appendix L

A Letter of Authorization for the *Graded Chinese Character Recognition Test* and *Chinese Version of Peabody Picture Vocabulary Test-Revised*

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同 意 書

本社（心理出版社股份有限公司）同意研究者詹益智有條件使用由黃秀霜所編製之「中文年級認字量表」與陸莉、劉鴻香所修訂之「修訂畢保德圖畫詞彙測驗（PPVT-R）」，以進行個人研究「Learning to Read Chinese: The Relative Roles of Phonological Awareness and Morphological Awareness.」，並要求遵守下列規範：

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