

Running head: WHAT SKILLS MAKE A DIFFERENCE IN READING CHINESE

Reading and spelling Chinese among beginning readers: What skills make a difference?

Pui-sze Yeung, Connie Suk-han Ho, Pakey Chik, Lap-yan Lo, and Hui Luan

The University of Hong Kong

David Wai-ock Chan

The Chinese University of Hong Kong

Kevin Kien-hoa Chung

The Hong Kong Institute of Education

Date of first submission: 3 June 2009

Address for correspondence:

Connie Suk-Han Ho

Department of Psychology

The University of Hong Kong

Pokfulam Road

Hong Kong

E-mail: [shhoc@hkucc.hku.hk](mailto:shhoc@hkucc.hku.hk)

Fax: (852) 2858 3518

Telephone: (852) 2241 5652

What skills make a difference in reading Chinese 2  
Abstract

The contributions of six important reading-related skills (phonological awareness, rapid naming, orthographic skills, morphological awareness, listening comprehension and syntactic skills) to Chinese word and text reading were examined among 290 Chinese first graders in Hong Kong. Rapid naming, but not phonological awareness, was a significant predictor of Chinese word reading and writing to dictation (i.e., spelling) in the context of orthographic skills and morphological awareness. Commonality analyses suggested that orthographic skills and morphological awareness each contributed significant amount of unique variance to Chinese word reading and spelling. Syntactic skills accounted for significant amount of unique variance in reading comprehension at both sentence and passage levels after controlling for the effects of word reading and the other skills, but listening comprehension did not. A model on the interrelationships among the reading-related skills and Chinese reading at both word and text levels was proposed.

(142 words)

## What skills make a difference in reading Chinese 3 Introduction

Research on learning to read Chinese, a nonalphabetic language, have generated many impressive findings in the past decade that have informed us about what skills may be universally important for reading while some may be specifically more important for learning individual languages, like morphological awareness for Chinese (e.g., Chan, Ho, Tsang, Lee, & Chung, 2006; Ho, Ng, & Ng, 2003; McBride-Chang & Ho, 2005; Shu, McBride-Chang, Wu, & Liu, 2006). Given the recent advancement in Chinese research, some issues still require further examination. First, while four main types of skills (phonological awareness, rapid naming, orthographic skills and morphological awareness) important to Chinese word reading and writing to dictation (i.e., spelling) were identified, these skills were rarely examined in the same study rendering it difficult to develop a comprehensive view of Chinese word reading and spelling. Second, studies on reading-related skills that are important to Chinese text reading are lacking. Third, there were few attempts to investigate the interrelationships among reading-related skills, Chinese word reading and Chinese text reading.

### *Characteristics of the Chinese writing system*

Since the reader may not be familiar with the Chinese language, we will first briefly describe the main characteristics of the Chinese orthography. The basic graphic unit in Chinese is a character. Each character represents a syllable and a morpheme, the smallest unit of meaning. There are about 4,600 – 4,900 commonly used Chinese characters in Hong Kong (Cheung & Bauer, 2002; Lee, 2000). Children in Hong Kong encountered about 1,300 new Chinese characters in grade one, around 36% of all the new Chinese characters they are to learn in elementary grades (Chung & Leung, 2008). Many words in Chinese are formed by combining different morphemes, (e.g., “foot-ball”, “basket-ball”, “hand-ball”, etc.) and we may derive the meaning of the whole

What skills make a difference in reading Chinese 4 word from its constituent morphemes. Given the characteristics of large number of homophones and word compounding in Chinese, awareness of morphemes is particularly important in learning to read Chinese (McBride-Chang, Wagner, Muse, Chow, & Shu, 2005).

About 80% to 90% of Chinese characters are ideophonetic compounds, each comprising a semantic and a phonetic component (stroke-pattern known as ‘radical’) (Kang, 1993). In general, the semantic radical in a Chinese character signifies the semantic category of the character. According to Chung and Leung (2008), 33% of the semantic-phonetic compound characters encountered by grade one students in Hong Kong were transparent (e.g., the character 媽 “mother” with the semantic radical 女 “female”), 22% were semi-transparent (e.g., the character 枯 “decay” with the semantic radical 木 “plant”) and 30% were opaque (e.g., the character 增 “increase” with the semantic radical 土 “soil”). The semantic radical often occupies a habitual position in a Chinese character – left or top. The sound of a Chinese character can be derived directly from its phonetic radical or indirectly by making an analogy with other characters having the same phonetic radical. The predictive accuracy of the pronunciation of an ideophonetic compound character from its phonetic radical is about 40% (Shu, Chen, Anderson, Wu, & Xuan, 2003; Zhou, 1980; Zhu, 1987). This drops to 23% to 26% if tone is taken into consideration (Chung & Leung, 2008; Fan, 1986; Shu et al., 2003; Zhou, 1980). Overall, semantic radicals are functionally more reliable than phonetic ones.

#### *Skills important to word reading in Chinese*

A recent study by Roman, Kirby, Parrila, Wade-Woolley and Deacon (2009) examining the same four reading-related skills among English speaking children in grades 4, 6, and 8 showed that phonological awareness, orthographic skills, and morphological awareness uniquely contributed to English real word and pseudoword reading but rapid naming did not. Rapid

What skills make a difference in reading Chinese 5  
naming predicted significant variance in reading beyond phonological awareness and morphological awareness but not orthographic knowledge. These results were in support of their hypothesis that the information inherent in a script is translated into the skills that are important in the development of reading abilities. Their results reflect the fact that “English is an alphabetic script in which written words reflect regularities based on sounds, meaning” (p. 109). Since the Chinese writing system represents sound and meaning differently from alphabetic languages, the kind of skills that are important to learning to read and write Chinese words are expected to be different from those found in alphabetic languages.

In contrast to the alphabetic writing system in which individual phonemes are represented by letters, phoneme-sized units are not represented in the writing system of Chinese. This may explain the findings that onset-rhyme awareness is more relevant to reading Chinese than phonemic awareness (Siok & Fletcher, 2001). So and Siegel (1997) found that performance on both tone and rhyme discrimination was highly correlated with word reading among grades 1 to 4 students in Hong Kong. Besides, the absence of direct symbol-sound correspondence in Chinese as in an alphabetic language system (Perfetti & Tan, 1998) limited the use of phonological recoding strategy and thus the role of phonological awareness in reading Chinese characters. This is in line with the findings that phonological awareness was comparatively less important in learning to read Chinese among children with developmental dyslexia and normal readers (Ho, Chan, Tsang, & Lee, 2002; Ho, Chan, Lee, Tsang, & Luan, 2004; McBride-Chang et al., 2005; Shu et al., 2006). Instead, rapid naming, which in part tap the ability for arbitrary association between sound and script, was a robust predictor of Chinese word reading across the elementary grades and the most dominant type of cognitive deficits among Chinese children with dyslexia (Ho et al., 2002; Ho et al., 2004).

According to Castles and Nation (2006), orthographic processing skills refer to the sensitivity to orthographic regularities in the language. While children learning to read alphabetic languages have to pay attention to the regularities of letter combination, children learning to read Chinese need to be sensitive to the regularities of character structure and the ortho-semantic and ortho-phonological regularities of the radicals. Knowledge of character structure was repeatedly found as a salient predictor of Chinese character reading among kindergarteners and early elementary grades children even after controlling for phonological skills (such as phonological awareness and phonological memory) (Chan et al., 2006; Ho, Chan, Chung, Lee, & Tsang, 2007; McBride-Chang & Ho, 2005). Other studies showed that the visual complexity in Chinese character recognition goes beyond the configuration of characters. For example, adult and child readers were found to readily make use of the ortho-semantic and ortho-phonological regularities of the radicals to interpret the meaning and pronunciation of characters and pseudocharacters (Chan & Nunes, 1998; Chen, 1995; Cheung, Chan, & Chong, 2007; Flores d'Arcais, 1992; Hue, 1992; Shu, Anderson, & Wu, 2000; Zhu, 1987). Some studies showed that semantic radicals are particularly potent in activating character recognition (Feldman & Siok, 1999) and influenced lexical decision performance (Li and Chen, 1999). Ho et al. (2003) investigated extensively children's radical knowledge among grade 1 – grade 5 Chinese children in Hong Kong. They found that children's overall knowledge of the position, function, and semantic category of semantic radicals was associated more strongly with word reading and sentence comprehension than all other tasks assessing radical knowledge.

The fact that the Chinese character is simultaneously a visual whole, a syllabic unit and a morpheme (the unit of meaning) contrasts with the units of writing in alphabetic scripts, letters, which indicate sound only and have no dovetailed relation with meaning. The script-sound-meaning

What skills make a difference in reading Chinese 7

convergence of the Chinese character can facilitate the process of understanding and retrieval of the meaning of multicharacter words as the component morphemes of multicharacter Chinese words provide meaningful cues (Hoosain, 1991). Knowledge of morphemes allows children to have an educated guess when they encounter unfamiliar words in isolation or in a passage (McBride-Chang et al., 2003; Shu et al., 2006). A series of studies conducted in Mainland China and Hong Kong showed that children's morphological awareness, including the ability to distinguish among meanings of homophones and morpheme construction skills, contributed significant amount of unique variance to Chinese word reading, word spelling and reading comprehension over and above phonological processing skills (McBride-Chang et al., 2003; McBride-Chang et al., 2005; Shu et al., 2006). Moreover, explicit instruction in the morphological structure of Chinese words was effective in enhancing children's ability to write characters (Packard et al., 2006).

Though there was substantial evidence showing the importance of phonological awareness, rapid naming, orthographic skills and morphological awareness in Chinese reading, they were rarely examined in the same study. The only one to date was the one-year longitudinal study by Tong, McBride-Chang, Shu & Wong (2009). They found that orthographic skills and morphological awareness of children in the third year of kindergarten (Time 1) in Hong Kong predicted their concurrent Chinese word reading, spelling and reading comprehension and their word reading one year later (Time 2). Time 1 rapid naming was uniquely associated with concurrent word reading and Time 2 literacy measures of word reading, spelling and reading comprehension. Time 1 Phonological awareness failed to explain unique variance in the word reading and reading comprehension across time and was uniquely associated with subsequent spelling only. The present study was designed to replicate these findings by utilizing different measures of the same four reading-related skills among children of similar age.

In addition, the unique and shared effects of orthographic skills and morphological awareness in Chinese word reading and spelling were examined by conducting commonality analyses (Pedhazur, 1982). One possible implication of the script-sound-meaning convergence of the Chinese character was the close relationships between orthographic skills and morphological awareness in Chinese word reading. Research has also raised the need to clarify the relationships between these two closely related constructs. For example, radical awareness, the understanding of the role of semantic radicals, was conceptualized as a kind of morphological awareness (apart from morpheme awareness and homograph awareness) in the study by Li, Anderson, Nagy, & Zhang (2002). Yet, radical has been shown to be an important orthographic processing unit in the study by Ho et al. (2003) and radical awareness is claimed to be directly related to orthographic processing (Wang, Cheng, & Chen, 2006). It was hypothesized that there would be marked overlap among the contributions of orthographic skills and morphological awareness to Chinese word reading and spelling.

#### *Skills important to text reading in Chinese*

Research on Chinese word reading far outnumbered those on Chinese text reading. There is a paucity of literature on the skills that are important to learning to read Chinese texts. Other than phonological awareness, rapid naming, orthographic skills and morphological awareness, the present study ventures to examine the contribution of listening comprehension and syntactic skills, two skills postulated to be important to text reading in alphabetic languages, in Chinese text reading. Following Leong and Ho (2008), Chinese text reading in the present study is conceptualized as the encoding and activating of relevant information which may or may not be stated explicitly in the text during the reading process. Two levels of text reading (sentence comprehension and passage comprehension) were examined.



According to the “simple view of reading” (Gough & Tunmer, 1986; Hoover & Gough, 1990), reading comprehension is proposed to be equal to the product of decoding and linguistic comprehension (also referred to as listening comprehension) in alphabetic languages. Yet, the role of listening comprehension in Chinese reading was rarely investigated. One exception was the study by Wong (2006) which showed that both Cantonese listening comprehension and Modern Standard Chinese listening comprehension made significant and unique contribution to reading comprehension among Chinese children with dyslexia. The extent to which these findings can be generalized to normally-achieving readers is not known. In the Chinese language, the written form (Modern Standard written Chinese) is almost consistent while there are over 241 dialects spoken in China (Chung & Leung, 2008). Researchers found that the linkage of oral language and literacy skills become weaker when the discrepancy between oral language and written language increases (e.g., Burke, Pflaum & Knafle, 1982; Troutman & Falk, 1982). Cantonese, the Chinese dialect spoken by the majority of Chinese in Hong Kong, differs in significant ways from Modern Standard written Chinese in both vocabulary and syntax. It is expected that the role of oral language skills, including listening comprehension, in literacy development among Hong Kong children is relatively less significant.

The “triangle model extended” recently proposed by Bishop and Snowling (2004) is one of the few models incorporating both single-word processing and processing at the level of sentence or paragraph. On reviewing the evidence on the reading difficulties encountered by children with dyslexia and specific language impairment, Bishop and Snowling (2004) reinstated the importance of context in language processing. Two major components of context, syntactic skills and discourse skills, were highlighted. Research on the importance of syntactic skills in learning to read Chinese was scarce. Chinese is usually referred to an impoverished system of

What skills make a difference in reading Chinese 10  
grammatical morphology (Li, Bates, & MacWhinney, 1993). There are no case markings, no  
tense suffixes, and no subject-verb agreement in terms of number or gender (Li, 1996).

According to Chang (1992), word order is the single most important syntactic device for  
sentence interpretation in Chinese. Chen and Wong (1991), and Chen, Lau and Yung (1993)  
showed that syntactic skills accounted for a substantial amount of variance in Chinese reading  
among grade 3 to grade 5 children in Hong Kong. So and Siegel (1997) showed that their oral  
cloze task which assessed children's understanding of acceptable word order in the absence of  
print was a strong predictor of word recognition in grades 1 to 4. Recent studies also showed that  
syntactic skills were significant predictors of reading comprehension among elementary grade  
students in Mainland China and Hong Kong (Chen & Chen, 2008; Chik et al., under review).

Only a few of the six important reading-related skills (phonological awareness, rapid  
naming, orthographic skills, morphological awareness, listening comprehension and syntactic  
skills) were examined in previous studies on Chinese text reading (Leong, Tse, Loh, & Hau,  
2008; Shu et al., 2006). Comparatively, Tong et al.'s (2009) study was more comprehensive by  
incorporating rapid naming, phonological awareness, orthographic skills and morphological  
awareness. Still, none of these studies investigated syntactic skills and listening comprehension.  
In the present study, all the six types of reading-related skills were incorporated. According to  
the "triangle" model (Seidenberg & McClelland, 1989), the most prominent model on single-  
word reading, reading words primarily involves the computation of three types of codes:  
orthographic, phonological and semantic. Rapid naming, phonological awareness, orthographic  
skills and morphological awareness which are closely related to the computation of these codes  
were expected to be important to word reading. However, it was hypothesized that their  
contribution to text comprehension became insignificant after controlling for word reading. On

What skills make a difference in reading Chinese 11  
the other hand, listening comprehension and syntactic skills were hypothesized to be significant contributors to text reading after controlling for the effect of word reading with reference to the claim of the “simple view of reading” (Gough & Tunmer, 1986; Hoover & Gough, 1990) and the “triangle model extended” (Bishop & Snowling, 2004) respectively.

To summarize, the first aim of the present study was to examine the contributions of the four main types of reading-related skills (phonological awareness, rapid naming, orthographic skills and morphological awareness) to Chinese word reading and spelling when they were investigated in the context of one another. In particular, the unique and shared effects of orthographic skills and morphological awareness in Chinese word reading and spelling were examined. The second aim was to find out the types of skills that are important to Chinese text reading. Finally, based on the multiple regression analyses addressing the first and second aims, a model conceptualizing the interrelationships among the reading-related skills, word reading and text reading in Chinese was proposed.

## Method

### *Participants*

Participants were 290 first-grade students (146 girls and 144 boys) recruited from two local primary schools in Hong Kong with normal intelligence (mean IQ=110) and a mean age of 6 years 7 months. Cantonese was the medium of instruction for Chinese language in the two schools. It is noteworthy that children in Hong Kong mostly learn to read Chinese characters with a “look and say” method and there is no phonetic system, like Pin-yin in the Mainland China, to assist Chinese character learning.

### *Measures*

#### *General reasoning ability*

What skills make a difference in reading Chinese 12

Participants' general reasoning ability was assessed by the Raven's standard progressive matrices. This is a standardized test for measuring nonverbal intelligence, including five sets of 12 items each. Each item consisted of a target matrix with a missing piece. The participants were required to pick, from six to eight alternatives, the best part to complete the target matrix. Scoring procedures were based on the local norm established by the Education Department of The Hong Kong Government in 1986.

#### *Oral vocabulary task*

The vocabulary knowledge of each participant was assessed by asking him/her to name the objects and to describe what were happening in a colored picture of a classroom scenario. Each vocabulary the participant named that was relevant to the context of the picture was given one mark. Repeated tokens of the same answer were not given additional marks.

#### *Phonological awareness*

A task modeled after rhyme detection subtest of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD) (Ho, Chan, Tsang, & Lee, 2000) was used to assess participants' rhyme awareness. In each trial, the participants were presented with three Chinese syllables through a computer audio system, along with their corresponding pictures to ease their memory load. The two target syllables share the same rhyme while the rhyme of the distractor syllable differs from the target syllables. The tone of the three syllables in each trial was the same. The onsets of the three syllables were different. The participants were asked to choose the target answers by circling the corresponding pictures. There were 12 trials (see sample items in the Appendix) and one mark was given for the correct answers in each trial.

#### *Orthographic skills*

The pseudo-character meaning judgment task used in the study by Ho et al. (2003) was

What skills make a difference in reading Chinese 13  
adapted to measure the children's overall knowledge of the habitual position, function, and semantic category of semantic radicals. In each trial, a pseudo-character was presented together with four pictures side-by-side (sample items appear in Appendix). Each pseudo-character was composed by one lexical or non-lexical semantic radical and one phonetic radical. The semantic radical occupies either the top, bottom, left or right position depending on their most common position in real words. Each picture holds a semantic association with a common semantic radical. The participants were asked to circle the picture which had a semantic association with the target semantic radical. To arrive at the correct answer, the participants need to identify the position and the semantic meaning of the target semantic radical. There were 16 trials and one mark was given for the correct answer in each item.

#### *Morphological awareness*

Participants' morphological awareness was assessed by a task modelled after the Morpheme Identification Test in the study by McBride-Chang, Shu, Zhou, Wat, and Wagner (2003) to assess children's ability to distinguish the meanings among homophones. In each item, three two-syllable Chinese words were orally presented to the participants and the words had an identical syllable at the same position (see sample items in the Appendix). One of the homophones has different meaning from the other two (e.g., election (選舉 *syun2 geoi2*) / choice (選擇 *syun2 zaak6*) / damage (損害 *syun2 hoi6*)). The participants were asked to identify the two words that had a syllable sharing the same meaning by circling the numbers (1, 2, or 3) assigned to the words according to the presentation order. No printed words were shown to the participants. To minimize the influence of orthographic knowledge, the written forms of most of the stimuli words were not commonly found in the printed materials for grade 1 students according to the Hong Kong Corpus of Primary School Chinese (Leung & Lee, 2002). There

What skills make a difference in reading Chinese 14  
were 15 items and one mark was given for each correct item.

### *Rapid naming*

Participants' rapid automatized naming (Denckla & Rudel, 1976) was measured by a rapid naming of numbers task. The digits 1, 2, 5, 6 and 8 were printed in a 5 x 8 matrix on an A4 size paper. The participants were instructed to name the digits from left to right and from top to bottom as quickly and accurately as possible. They were asked to do the naming task twice. The average latency across the two trials was computed to the nearest 1/100 second and errors were recorded.

### *Listening comprehension*

Participants' listening comprehension ability was assessed by a task in which three sentences and three stories were played to the participants through a computer audio system. After listening to each target sentence, the participants were presented with another three sentences and were asked to decide which of these best represented the meaning of the target sentence. As for the three stories, each story was followed by three types of questions - one on the literal information in the story, one on an inference based on the story and one on the theme of the story. There were three choices for each question. The length, topic and vocabulary used in the stories were similar to those commonly found in Chinese language textbooks for grade 2 students in Hong Kong. One mark was given for the correct answer to each question. An example is provided in the Appendix.

### *Syntactic skills*

The oral cloze task adapted from So and Siegel's (1997) study was used to measure the participants' understanding of acceptable word order in the sentence structure. Nine audio-recorded sentences, each with one word missing, were presented to the child in the absence of

What skills make a difference in reading Chinese 15 print (see sample items in Appendix). Three classes of missing words were used: nouns, verbs and adjectives. Instructions and the trial item were repeated (up to three times) until the child understood how the task should be performed. Then, the test sentences were presented. The responses were audio-recorded and scored according to their syntactic appropriateness on a four-point scale according to three aspects: part of speech, semantic meaning and conformity to Modern Standard Chinese.

### *Word Reading*

The Chinese Word Reading subtest of the HKT-SpLD (Ho et al., 2000) was used to assess the participants' word reading performance. The participants were asked to read aloud 150 Chinese two-character words in the order of graded difficulty. The test was discontinued when the child failed to read 15 words consecutively. One mark was given to each word correctly read.

### *Word Spelling*

The Chinese word writing for dictation task was made up of thirteen two-character Chinese words selected from popular Chinese textbooks for first graders in Hong Kong (sample items appear in Appendix). In each trial, the participants were asked to write down the target word which was read aloud three times by the experimenter: first in isolation, then embedded in a simple sentence, and lastly on its own again. One mark was given for each correctly written character.

### *Sentence comprehension*

Children's sentence comprehension ability was assessed by a cloze sentence task. There were twelve cloze sentences with a noun, a verb, an adjective or an adverb missing in each sentence (see sample items in Appendix). The participants were required to choose, from four choices, the word that best completed the sentence. All four choices in the same item were of the

What skills make a difference in reading Chinese 16  
same word class but were different in terms of meaning and usage. To arrive at the correct answer, the child needs to make use of and integrate the information available in each cloze sentence. One mark was given for the correct answer in each sentence. The participants were given two practice items before the testing ones.

#### *Passage comprehension*

The children were presented with three passages written for this task. The content and the length of the passages were appropriate to grade 1 students with reference to the textbook and reading materials written for grade 1 students in Hong Kong. Each passage was followed by three multiple-choice questions testing the participants' reorganization and inferential comprehension ability. Students not only need to use and combine information from various parts of the text but also need to combine their literal understanding of the text with their own knowledge and intuition for additional understanding. There were three choices for each question (see an example in the Appendix). One mark was given for the correct answer in each question.

#### *Procedures*

The tasks were administered to the participants in a number of group testing (around 60 minutes each) and individual testing (around 30 minutes each) sessions. Tasks on general reasoning ability, phonological awareness, orthographic skills, morphological awareness, listening comprehension, word spelling, sentence comprehension and passage comprehension were administered in groups. Tasks on rapid naming, syntactic skills and word reading were administered individually.

#### Results



Table 1 presents the means, standard deviations, reliability coefficients and ranges for the tasks undertaken in this study. In general, the reliability of the tasks in this study was acceptable with reliability coefficients ranging from .51 to .96 for most tasks, except for the listening comprehension task with a reliability coefficient of .38.

#### *Correlation*

Table 2 shows the correlations among age, IQ, oral vocabulary, the six reading-related skills and literacy measures in the study. Most of the correlations among the six reading-related skills were statistically significant, except that between phonological awareness and syntactic skills. The significant correlation coefficients among the six reading-related skills were in the range of .15 to .43 reflecting low to medium strength of relationships. The four literacy measures were more highly correlated with one another ( $r_s > .42, p_s < .001$ ). All the correlations between the six reading-related skills and Chinese literacy measures were significant.

#### *Multiple Regression Analyses*

To examine the first research question about the unique contribution of each reading-related skills to Chinese word reading and spelling, two multiple regression analyses were conducted. In each regression equation, the control variables of age, IQ scores and oral vocabulary were entered in the first step. The variables of phonological awareness, rapid naming, orthographic skills and morphological awareness were entered into the equation simultaneously in the second step. The results of these analyses are shown in Table 3 with Chinese word reading and spelling as the dependent variables. Rapid naming, orthographic skills and morphological awareness each made unique contribution to both word reading and spelling. These significant predictors together accounted for 34% ( $F(4, 268) = 41.26, p < .001$ ) of the variance in word

What skills make a difference in reading Chinese 18 reading and 24% ( $F(4, 268) = 22.69, p < .001$ ) of the variance in word spelling. Phonological awareness was not a significant predictor of word reading and spelling after controlling for the contribution by other variables.

To examine the unique and shared effects of orthographic skills and morphological awareness in word level literacy, commonality analyses (Pedhazur, 1982) with word reading and spelling as dependent variables were conducted. There were three blocks of independent variables. One consisted of the control variables of age, IQ and oral vocabulary. The other two were orthographic skills and morphological awareness. The commonality analyses results (Table 4) showed that both orthographic skills and morphological awareness accounted for a substantial amount of unique variance in word reading while morphological awareness accounted for the greatest amount of unique variance in word spelling. The shared variance of orthographic skills and morphological awareness was quite small, 0.023 for word reading and 0.001 for word spelling.

Two hierarchical multiple regression analyses with sentence comprehension and passage comprehension as the dependent variables were conducted to test the hypothesis that listening comprehension and syntactic skills had significant contribution to text level reading after controlling for the effect on word reading while phonological awareness, rapid naming, orthographic skills and morphological awareness did not have. In each of these regression equations, age, IQ and oral vocabulary were entered in the first step. To control for the effect of word reading, it was entered in the second step. The variables of phonological awareness, rapid naming, orthographic skills, morphological awareness, listening comprehension, and syntactic skills were entered into each regression equation simultaneously in the third step. Results were shown in Table 5. Word reading accounted for 45% ( $F(1, 269) = 285.77, p < .001$ ) of the

What skills make a difference in reading Chinese 19  
variance in sentence comprehension and 23% ( $F(1, 269) = 99.36, p < .001$ ) of the variance in  
passage comprehension. After controlling for the contribution of word reading, all variables  
together accounted for additional 3% ( $F(6, 263) = 3.24, p < .01$ ) of variance in sentence  
comprehension and 5% ( $F(6, 263) = 3.75, p < .01$ ) of variance in passage comprehension. After  
controlling for word reading, only syntactic skills uniquely predicted both sentence and passage  
comprehension. Orthographic skills significantly predicted sentence comprehension and rapid  
naming significantly predicted passage comprehension.

### *A Model of Reading in Chinese*

The associations among the variables and modeling Chinese reading at both word and  
text levels were investigated by running the path analyses using LISREL 8.80, a structural  
equation modeling program. The first path analyses model (Model 1) served as a baseline model  
(Figure 1). Phonological awareness, rapid naming, orthographic skills and morphological  
awareness were postulated to have significant effects on word reading while listening  
comprehension and syntactic skills were postulated to have significant effects on text level  
reading. Word reading was proposed to contribute significantly to sentence comprehension and  
passage comprehension. Sentence comprehension was proposed to have a significant effect on  
passage comprehension. The overall fit of Model 1 was moderate ( $\chi^2(2, N = 270) = 8.97, p =$   
0.011, Non-Normed Fit Index (NNFI) = 0.88, Comparative Fit Index (CFI) = 0.99 and Root  
Mean Square Error of Approximation (RMSEA) = 0.115). Model 2 was postulated based on the  
multiple regression results (Figure 2). Rapid naming, morphological awareness and orthographic  
skills were proposed to have significant effects on word reading. Only orthographic skills and  
syntactic skills had significant effects on sentence comprehension while rapid naming and  
syntactic skills had significant effects on passage comprehension. All paths postulated were

What skills make a difference in reading Chinese 20 significant, except that from rapid naming to passage comprehension. Model 2 fits the data well ( $\chi^2 (11, N = 270) = 16.39, p = 0.127$ , Non-Normed Fit Index (NNFI) = 0.98, Comparative Fit Index (CFI) = 0.99 and Root Mean Square Error of Approximation (RMSEA) = 0.043). The overall fit of Model 2 was as good as that of Model 1 ( $\Delta\chi^2 (9, N = 270) = 7.42, p > 0.50$ ). Since Model 2 fits the data as good as that of Model 1 and is simpler than Model 1, it is the preferred model conceptualizing the interrelationships among the variables in the study.

## Discussion

### *Important skills for word reading and spelling in Chinese*

In the present study, the contribution of phonological awareness, rapid naming, orthographic skills and morphological awareness to Chinese word reading and spelling were investigated in the context of the other variables. Results of the multiple regression analyses revealed that rapid naming, orthographic skills and morphological awareness made independent contributions to Chinese word reading and spelling after the contributions by the other variables were controlled for but phonological awareness did not. The pattern of results was similar to those found in the study by Tong et al. (2009) among young Chinese children. As expected, rapid naming contributed more to Chinese word reading and spelling than phonological awareness. Morphological awareness and orthographic skills were significant predictors of Chinese word reading and spelling in the context of the other variables. Contrary to our hypothesis, the amount of shared variance in word reading and spelling by these two variables in the commonality analyses was relatively small. These clearly demonstrated that orthographic skills and morphological awareness are unique and significant contributors to Chinese word reading and spelling.

Taken together, our results were consistent with Roman et al.'s (2009) proposal that the

What skills make a difference in reading Chinese 21  
information conveyed in a given script determines the skills important for reading development.

The less significant role of phonological awareness in reading Chinese words may reflect the fact that the smallest orthographic unit of Chinese is relatively coarse, less detailed phonological analysis is involved when reading it (Upward, 1999). Naming Chinese characters are likely to involve automatic extraction of orthographic patterns and name retrieval from memory (Ho et al., 2002), resembling the processes behind rapid naming. This is especially the case in Hong Kong where children learn to read Chinese characters by the “look and say” method. The significant contribution of orthographic skills, in terms of knowledge related to semantic radicals, to Chinese word reading is consistent with the general consensus that most Chinese semantic radicals provide a useful cue to the meaning of whole characters (Feldman & Siok, 1998). The semantic cues offered by the semantic radicals facilitate children’s ability to retrieve the sound of the character via the orthography-semantic-phonology pathway. Being able to locate the semantic radical in a character also means one could locate the phonetic radical (i.e., the non-semantic component) which provides cues to the pronunciation of the ideophonetic compound characters in Chinese. The findings on the important role of morphological awareness in Chinese word reading were consistent with previous studies by McBride-Chang and colleagues (e.g., McBride-Chang et al., 2003; McBride-Chang et al., 2005; Shu et al., 2006). As suggested by Tong et al. (2009), the pervasive number of homophones in Chinese makes phonological information relatively unreliable in identifying characters. Children’s accuracy in character naming and spelling is likely to be closely related to children’s awareness that identical sounds might represent different meanings in different word context, as assessed in the morphological awareness task in the present study.

The present findings also have implications for the conceptualization of Chinese reading in light of a connectionist account of reading by Plaut, McClelland, Seidenberg, and Patterson (1996).

Their general lexical framework for word reading proposed that orthography can influence phonology either directly or via semantics. There is a partial division of labor between a phonological pathway and a semantic pathway; both operate according to a common set of computational principles (see Plaut et al. (1996) for more detailed account of the differences between their model and dual-route theories). As learning continues, the phonological pathway is more adept in pronouncing consistent spelling-sound correspondences and the semantic pathway is more depended on in the pronunciation of words, especially exception words (Nation & Snowling, 1998). Other than changes in reading experience, the interaction between the phonological and the semantic pathways is likely to be affected by the way written units are connected with the units of knowledge in different writing systems. The assembly of phonology in an alphabetic language system is not possible in Chinese as there is no direct symbol-sound correspondence and the phonological information obtained from the phonetic radicals is not segmental (Leong, Cheng, & Lam, 2000). It is hypothesized that the semantic pathway should play a more important role in reading Chinese characters than in reading alphabetic languages. Two findings supported this suggestion. First, phonological awareness which facilitates the phonological pathway functioning was relatively less significant in reading Chinese characters. Second, our tasks tapping orthographic skills and morphological awareness are both closely associated with the semantic aspects of the language. The former not only assessed participants' knowledge about the positional regularity of the semantic radicals but also their knowledge about the semantic category signified by the semantic radicals. The latter measured children's understanding of the meaning represented by homophones. These observations echoed the findings in Ho et al.'s (2007) study where the correlation between Chinese exception character and pseudocharacter reading ( $r = .83$ ) was much higher than the correlation between English exception word and nonword reading (approximately .48 in Manis,

What skills make a difference in reading Chinese 23

Seidenberg, Doi, McBride-Chang, & Petersen, 1996). Unlike reading nonwords in English which primarily involves the phonological pathway, it was argued that Chinese pseudocharacters are mainly read by the lexical route (i.e., the ‘semantic pathway’) as the pronunciation of Chinese pseudocharacters can either be directly derived from the sound of the phonetic radical or indirectly from the sound of other characters containing the same phonetic radical.

### *A Model of Reading in Chinese*

The present study ventures to propose a theoretical model (see Figure 2) reflecting the componential aspect of Chinese reading at word and text levels simultaneously based on the multiple regression analyses results. The overall fit of the proposed model was good. One novel feature of the present study was that the relationships among three levels of Chinese reading, namely word, sentence and passage were studied in the path model alongside with their relationships with reading-related skills. In the proposed model, word reading had significant effects on sentence comprehension and passage comprehension. Sentence comprehension had significant influence on passage comprehension. In general, the relationships among the reading-related skills and the literacy measures in the proposed model of Chinese reading were consistent with the hypotheses. First, the model proposed that rapid naming, orthographic skills and morphological awareness had significant effects on word reading. Rapid naming and morphological awareness did not contribute to sentence and passage comprehension after controlling for the effects of word reading and other variables. These were in line with both the “triangle” models (Plaut et al., 1996; Seidenberg & McClelland, 1989) and the blueprint model of the reader (Verhoeven & Perfetti, 2008) in that the primary role of reader’s representation of orthography, phonology, morphology and meaning is to facilitate the identification of individual words. Second, syntactic skills had significant effects on sentence comprehension and passage

What skills make a difference in reading Chinese 24  
comprehension even after controlling for the influence of word reading and other reading-related skills. This provides empirical support to the “triangle model extended” (Bishop & Snowling, 2004) which emphasized the importance of syntactic skills in text level processing. It also reiterates the prominent role of word order in signifying grammatical relations (Chao, 1968) and meaning at the sentence level in Chinese (Hoosain, 1991). Still, previous studies investigating text comprehension using other research methods suggested that the significance of word order in sentence comprehension may change with ages. For example, Miao (1981) and Miao, Chen, and Ying (1984) showed that Chinese adults and most children relied more on semantic strategy (e.g., word meanings) than syntactic strategy (e.g., word order) in sentence comprehension. Yet, children of five to seven years of age relied more on word order cue in their comprehension of noun-verb-noun sentences, the canonical word order. The role of syntactic skills in Chinese reading development is likely to be a promising direction for future studies.

There were three findings that were not consistent with the original hypotheses. First, orthographic skills had a significant effect on sentence comprehension after controlling for the effects of word reading and other variables. In the study by Ho et al. (2003), children’s knowledge of the function and semantic category of semantic radicals was also significantly associated to sentence comprehension but word reading was not controlled in their analyses. Semantic radicals are important cues to the meaning of compound characters in Chinese. Knowledge of the semantic category of semantic radicals may contribute to the understanding of word meaning which in turn facilitates sentence understanding. By controlling for word reading, we only controlled for the participants’ ability to read out but not their understanding of the words. Besides, this might imply that the semantic codes play a more important role in text comprehension in Chinese than in alphabetic languages. Compared to alphabetic languages,



Chinese language lacks inflections, and has less clear form-class classification and word boundaries. Readers have to pay more attention to the semantic relations of character sequence in reading Chinese than in reading alphabetic languages (Hoosain, 1991). An alternative explanation is that the orthographic skills task is tapping an ability (e.g., word semantics) that has a significant effect on sentence comprehension. To verify these explanations, future studies incorporating a measure of word meaning are needed.

Second, listening comprehension did not have a significant effect on sentence or passage comprehension. Listening comprehension was postulated to be of great importance to reading comprehension in alphabetic languages. Though not in line with the “simple view of reading” (Gough & Tunmer, 1986; Hoover & Gough, 1990) for alphabetic languages, this finding supported the speculation that the linkage of oral language and literacy skills is likely to be weaker given the discrepancies between the oral language and written language used by Hong Kong Chinese children. Since the spoken form (Cantonese) and the written form (Modern Standard Chinese) denoting the same meaning can differ in significant ways, Hong Kong children may not be able to understand the meaning of the written form even if they could read out the written form. This inevitably limits the impact of children’s listening comprehension skills on their reading comprehension. One point to note was that the reliability of the listening comprehension task was less than satisfactory. The abovementioned speculation has to be verified in future studies with more refined and reliable measures of listening comprehension.

Third, rapid naming was a significant contributor to passage comprehension after controlling for word reading and other variables in the multiple regression analyses. This is compatible with the proposal that automatic processing at the word level render more cognitive resources be available for comprehending the meaning of the text (Adams, 1990; LaBerge &

What skills make a difference in reading Chinese 26  
Samuels, 1974; Samuels, 1999). It is possible that reading comprehension beyond sentence level is more cognitive resources taxing and thus is more sensitive to measures of automaticity. Still, these results need to be interpreted with cautions as the path between rapid naming and passage comprehension was not significant in the path analyses.

To sum up, these findings are consistent with the models of text comprehension (e.g., Bishop & Snowling, 2004; Perfetti, 1999) which suggest that text comprehension requires more than word identification. Other than word meaning, sentence structure is important in formulating hypotheses about the meaning of the sentence (Verhoeven & Perfetti, 2008). This may explain why syntactic skills was closely related to reading comprehension. Researchers have also proposed other important contributors to text level processing, such as discourse skills (Bishop & Snowling, 2004) and verbal working memory (Leong et al., 2008). There are some recent attempts to validate these models on text comprehension in alphabetic languages (e.g., Hagoort, 2005; Perfetti, 2007). Future studies examining text comprehension in Chinese along the same line are necessary for the formulation of universal models of text comprehension across languages.

### *Conclusion*

Findings in the present study facilitate attempts to develop a more comprehensive view of learning to read Chinese at word and text levels and provide the empirical basis for formulating a clear framework for developing an effective literacy curriculum with core training components corresponding to the important skills identified. Studies on the effectiveness of training programmes on these reading-related and literacy skills will reveal possible causal relationships between these skills and the reading outcomes. Another theoretical question that still awaits further exploration is the nature of the ability revealed in rapid naming tasks, which plays such

What skills make a difference in reading Chinese 27

an important role in learning to read Chinese. Wolf and Bowers (1999) cited studies showing that articulation rate (Scarborough & Domgaard, 1998), global processing speed measures (such as symbol search, coding and cross-out tasks) (Kail & Hall, 1994; Kail, Hall, & Caskey, 1999; McBride-Chang & Kail, 2002), and the interstimulus intervals or time between the articulation of the names (Obregón, 1994 as cited in Wolf & Bowers, 1999) were significantly correlated with serial naming speed. Results from the study by McBride-Chang and Ho (2000) on Chinese kindergarteners suggested that naming speed may be particularly associated with visual skills and graphological knowledge. Still, no consensus has been reached and much remains to be explored. This study had at least three limitations. First, reliability of the listening comprehension task was less than satisfactory. Future studies with more reliable measures of listening comprehension should be conducted to verify the role of listening comprehension in Chinese text reading. It is also noted that results in the study were based on the performance of Chinese first graders. The proposal discussed should better be placed into a developmental context where the relationships among the reading-related skills and reading measures could be evaluated at various developmental levels of reading. Data from longitudinal studies are needed for building up a developmental model for Chinese reading acquisition. Besides, only one measure was used to estimate each construct in the study. Attempts to develop a model where each construct is estimated by more measures are called for in view of the complexity of the constructs.

What skills make a difference in reading Chinese 28  
Author Note

This research was funded by the READ & WRITE: A Jockey Club Learning Support Network from The Hong Kong Jockey Club Charities Trust. Special thanks are due to Ms. Suk-han Lee and Ms. Suk-man Tsang, Education Bureau, Hong Kong Special Administrative Region Government, Hong Kong, China, for their valuable advices and suggestions. The authors would like to thank the support of teachers and students of the two participating schools.

- Adams, M. J. (1990). *Beginning to read: thinking and learning about print*. Cambridge, MA: The MIT Press.
- Bishop, D. V. M., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin*, *130*, 858-886.
- Burke, S. M., Pflaum, S. W., & Knafle, J. D. (1982). The influence of Black English on diagnosis of reading in learning disabled and normal readers. *Journal of Learning Disabilities*, *15*, 19-22.
- Castles, A., & Nation, K. (2006). How does orthographic learning happen? In S. Andrews (Ed.), *From inkmarks to ideas: Current issues in lexical processing* (pp. 151-179). Hove: Psychology Press.
- Chan, D. W., Ho, C. S. H., Tsang, S. M., Lee, S. H., & Chung, K. K. H. (2006). Exploring the reading-writing connection in Chinese children with dyslexia in Hong Kong. *Reading and Writing*, *19*, 543-561.
- Chan, L., & Nunes, T. (1998). Children's understanding of the formal and functional characteristics of written Chinese. *Applied Psycholinguistics*, *19*, 115-131.
- Chang, H. W. (1992). The acquisition of Chinese syntax. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language processing in Chinese. Advances in psychology*, *90* (pp. 277-311). Oxford, England: North-Holland.
- Chao, Y. R. (1968). *A grammar of spoken Chinese*. Berkeley: University of California Press.
- Chen, B., & Chen, Y. (2008). The relationships of primary school students' syntactic awareness and phonological awareness with their performance of reading comprehension. *Psychological Science*, *31*(4), 892-895.
- Chen, M. J., Lau, L. L., & Yung, Y. F. (1993). Development of component skills in reading Chinese. *International Journal of Psychology*, *28*, 481-507.
- Chen, M. J., & Wong, A. (1991). Component skills as predictors of Chinese reading proficiency in primary school children. *International Journal of Psychology*, *26*, 53-70.
- Chen, Y. P. (1995). Attention and lexical decomposition in Chinese word recognition: conjunctions of form and position guide selective attention. *Visual Cognition*, *2*, 235 – 268.
- Cheung, K., & Bauer, R. S. (2002). The representation of Cantonese with Chinese characters. *Journal of Chinese Linguistics Monograph Series*, *18*, 487.
- Cheung, H., Chan, M., & Chong, K. (2007). Use of orthographic knowledge in reading by Chinese-English bi-scriptal children. *Language Learning*, *57*, 469-505.

- Chik, P. P.-M., Ho, C. S.-H., Yeung, P.-S., Luan, H., Lo, L.-Y., Chan, D. W., Chung, K. K., & Lau, W. (under review). *Syntactic skills in Chinese text-level reading among Chinese elementary school children*. Manuscript submitted for publication.
- Chung, F. H. K., & Leung, M. T. (2008). Data analysis of Chinese characters in primary school corpora of Hong Kong and mainland China: Preliminary theoretical interpretations. *Clinical Linguistics & Phonetics*, 22 (4-5), 379-389.
- Denckla, M. B., & Rudel, R. (1976). Rapid automatised naming (R. A. N.): Dyslexia differentiated from other learning disabilities. *Neuropsychologia*, 14, 471 – 479.
- Fan, K. Y. (1986, September). *Graphic symbol of Chinese character modernization*. Paper presented at the meeting of the Symposium of Chinese Character Modernization, Beijing, China.
- Feldman, L. B., & Siok, W. W. T. (1999). Semantic radicals in phonetic compounds: Implications for visual character recognition in Chinese. In J. Wang, A. W., Inhoff, & H. C. Chen (eds.), *Reading Chinese Script: A Cognitive Analysis*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Flores d'Arcais, G. B. (1992). Graphemic, phonological and semantic activation processes during the recognition of Chinese characters. In H. C. Chen & O. J. L. Tzeng (Eds.), *Language processing in Chinese* (pp. 37-66). Amsterdam: Elsevier Science.
- Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading and reading disability. *Remedial and Special Education*, 7 (1), 6 – 10.
- Hagoort, P. (2005). On broca, brain, and binding: A new framework. *Trends in Cognitive Sciences*, 9, 416-426.
- Ho, C. S. H., Chan, D. W., Chung, K. K. H., Lee, S. H., & Tsang, S. M. (2007). In search of subtypes of Chinese developmental dyslexia. *Journal of Experimental Child Psychology*, 97, 61-83.
- Ho, C. S. H., Chan, D. W. O., 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., Chan, D. W. O., Tsang, S. M., & Lee, S. H. (2000). *The Hong Kong Test of Specific Learning Difficulties in Reading and Writing*. Hong Kong: Hong Kong Specific Learning Difficulties Research Team.
- Ho, C. S. H., Chan, D. W. O., Tsang, S. M., & Lee, S. H. (2002). The cognitive profile and multiple-deficit hypothesis in Chinese developmental dyslexia. *Developmental Psychology*, 38, 543 – 553.
- 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, 849-878.

- Hoosain, R. (1991). *Psycholinguistic implications for linguistic relativity: a case study of Chinese*. New Jersey: Lawrence Erlbaum Associates, Inc.
- Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal*, 2, 127-160.
- Hue, C. W. (1992). Recognition processes in Chinese naming. In H. C. Chen & O. J. L. Tzeng, (Eds.), *Language processing in Chinese* (pp. 93-107). Amsterdam: Elsevier Science.
- Kail, R. & Hall, L. K. (1994). Processing speed, naming speed, and reading. *Developmental Psychology*, 30, 949 – 954.
- Kail, R., Hall, L. K., & Caskey, B. J. (1999). Processing speed, exposure to print, and naming speed. *Applied Psycholinguistics*, 20, 303 - 314.
- Kang, J. S. (1993). Analysis of semantics of semantic-phonetics compound characters in modern Chinese. In Y. Chen (Ed.), *Information analysis of usage of characters in modern Chinese* (pp. 66-83). Shanghai, China: Shanghai Education.
- LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 6, 293 – 323.
- Lee, H. M. (Ed.). (2000). *常用字字形表 [Commonly Used Chinese Character Set]*. Hong Kong: Hong Kong Institute of Education.
- Leong, C. K., Cheng, P. W., & Lam, C. C. C. (2000). Exploring reading-spelling connection as locus of dyslexia in Chinese. *Annals of Dyslexia*, 50, 239-259.
- Leong, C. K., & Ho, M. K. (2008). Theory-based assessment of reading and its difficulties in the Chinese language system. *Hong Kong Journal of Paediatrics*, 13, 1-12.
- Leong, C. K., Tse, S. K., Loh, K. Y., & Hau, K. T. (2008). Text comprehension in Chinese children: Relative contribution of verbal working memory, pseudoword reading, rapid automated naming, and onset-rime phonological segmentation. *Journal of Education Psychology*, 100, 135-149.
- Leung, M. T., & Lee, A. W. Y. (2002). *The Hong Kong Corpus of primary School Chinese*. Paper presented at the 9<sup>th</sup> meeting of the International Clinical Phonetics and Linguistics Association. Hong Kong
- Li, H., & Chen, H. C. (1999). Radical processing in Chinese character recognition: evidence from lexical decision. *Psychologia*, 42, 199 – 208.
- Li, P. (1996). Spoken word recognition of code-switched words by Chinese-English bilinguals. *Journal of Memory and Language*, 35, 757-774.

- Li, P., Bates, E., & MacWhinney, B. (1993). Processing a language without inflections: A reaction time study of sentence interpretation in Chinese. *Journal of Memory and Language*, 32, 169-192.
- Li, W., Anderson, R. C., Nagy, W., & Zhang, H. (2002). Facets of metalinguistic awareness that contribute to Chinese literacy. In W. Li, J. Gaffney, & J. Packard (Eds.), *Chinese children's reading acquisition. Theoretical and pedagogical issues*. London: Kluwer Academic Publishers.
- Manis, F. R., Seidenberg, M. S., Doi, L. M., McBride-Chang, C., & Petersen, A. (1996). On the bases of two subtypes of developmental dyslexia. *Cognition*, 58, 157-195.
- McBride-Chang, C., & Ho, C. S. H. (2000). Naming speed and phonological awareness in Chinese children: Relations to reading skills. *Journal of Psychology in Chinese Societies*, 1, 93 – 108.
- McBride-Chang, C., & Ho, C. S. H. (2005). Predictors of beginning reading in Chinese and English: A 2-year longitudinal study of Chinese kindergartens. *Scientific Studies of Reading*, 9, 117 – 144.
- McBride-Chang, C., & Kail, R. V. (2002). Cross-cultural similarities in the predictors of reading acquisition. *Child Development*, 73 (5), 1392 – 1407.
- McBride-Chang, C., Shu, H., Zhou, A., Wat, C. P., & Wagner, R. K. (2003). Morphological awareness uniquely predicts young children's Chinese character recognition. *Journal of Educational Psychology*, 95, 743-751.
- McBride-Chang, C., Wagner, R. K., Muse, A., Chow, B. W. Y., & Shu, H. (2005). The role of morphological awareness in children's vocabulary acquisition in English. *Applied Psycholinguistics*, 26, 415-435.
- Miao, X. C. (1981). Word order and semantic strategies in Chinese sentence comprehension. *International Journal of Psycholinguistics*, 23, 109-122.
- Miao, X. C., Chen, G. P., Ying, H. C. (1984). Reexamination of the roles of word order and lexical meaning in Chinese sentence comprehension. *Information on Psychological Science*, 6, 1-7.
- 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.
- Packard, J. L., Chen, X., Li, W., Wu, X., Gaffney, J. S., Li, H., & Anderson, R. C. (2006). Explicit instruction in orthographic structure and word morphology helps Chinese children learn to write characters. *Reading and Writing*, 19, 457-487.
- Pedhazur, E. J. (1982). *Multiple regression in behavioral research* (2nd ed.). New York: Holt, Rinehart, and Winston.



- Perfetti, C. A. (1999). Cognitive research and the misconceptions of reading education. In J. Oakhill & R. Beard (Eds.), *Reading development and the teaching of reading: a psychological perspective* (pp. 42-58). Oxford, England: Blackwell Science.
- Perfetti, C. A. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading. Special Issue: What Should be the Scientific Study of Reading be now and in the Near Future?*, 11, 357-383.
- Perfetti, C. A., & Tan, L. H. (1998). The time course of graphic, phonological, and semantic activation in Chinese character identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 101-118.
- 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.
- Roman, A. A., Kirby, J. R., Parrila, R. K., Wade-Woolley, L., & Deacon, S. H. (2009). Toward a comprehensive view of the skills involved in word reading in Grades 4, 6 and 8. *Journal of Experimental Child Psychology*, 102, 96-113.
- Samuels, S. J. (1999). Developing reading fluency in learning-disabled students. In R. J. Sternberg & L. Spear-Swerling (Eds.), *Perspectives on learning disabilities: biological, cognitive, contextual* (pp. 176-189). Boulder, Colorado: Westview.
- Scarborough, H. S., & Domgaard, R. M. (1998, April). *An exploration of the relationship between reading and rapid serial naming*. Poster presented at meeting of the annual the Society for the Scientific Study of Reading, San Diego, CA.
- Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming, *Psychological Review*, 96, 523 – 568.
- 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, 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.
- Siok, W. T., & Fletcher, P. (2001). The role of phonological awareness and visual-orthographic skills in Chinese reading acquisition. *Developmental Psychology*, 37 (6), 886-899.
- So, D., & Siegel, L. S. (1997). Learning to read Chinese: Semantic, syntactic, phonological and working memory skills in normally achieving and poor Chinese readers. *Reading and Writing: An Interdisciplinary Journal*, 9, 1-21.

- Tong, X. , McBride-Chang, C., Shu, H., & Wong, A. M-Y. (2009). Morphological awareness, orthographic knowledge, and spelling errors: keys to understanding early Chinese literacy acquisition. *Scientific Studies of Reading, 13*, 426-452.
- Troutman, D. E., & Falk, J. S. (1982). Speaking Black English and reading: Is there a problem of interference? *Journal of Negro Education, 51*, 123-133.
- Upward, C. (1999). Anglo (- Japanese Non - ) Dyslexia. *Journal of the Simplified Spelling Society, 26*, 30 – 31. Retrieved July 26, 2004, from <http://www.spellingsociety.org/journals/j26/japanese.php>
- Verhoeven, L., & Perfetti, C. (2008). Introduction: Advances in text comprehension: Model, process and development. *Applied Cognitive Psychology. Special Issue: Advance in Text Comprehension: Model, Process and Development, 22*, 293-301.
- Wang, M., Cheng, C. X., Chen, S. W. (2006). Contribution of morphological awareness to Chinese-English biliteracy acquisition. *Journal of Educational Psychology, 98*, 542-553.
- Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexia. *Journal of Educational Psychology, 91*, 415 – 438.
- Wong, Y. K. (2006). *Listening and reading comprehension of Chinese dyslexic children speaking the Cantonese dialect*. Unpublished master's thesis, University of Hong Kong, Hong Kong.
- Zhou, Y. K. (1980). *Precise guide to pronunciation with Chinese phonological roots*. Jilin, China: People's Publishing.
- Zhu, Y. P. (1987). *Analysis of cuing functions of the phonetic in modern China*. China: East China Normal University.

What skills make a difference in reading Chinese 35  
Appendix



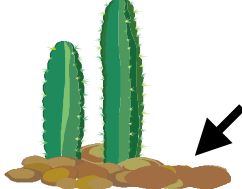

Sample Chinese Items with English Translation



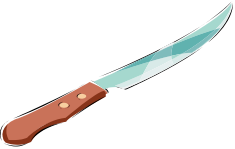

1. Phonological awareness: Rhyme detection task

1a 店[dim3] 劍[gim3] 傘[saan3]

1b 心[sam1] 刀[dou1] 煲[bou1]

2. Orthographic skills: Pseudo-character meaning judgment task

2a.	愧		
			

2b.	司		
			

3. Morphological awareness: Morpheme identification task

3a 地板 黑板 出版  
[dei6 baan2/floor] [hak1 baan2/blackboard] [ceot1 baan2/publishing]

3b 說話 雪櫃 雪糕  
[syut3 waa6/a chat] [syut3 gwai6/fridge] [syut3 gou1/ice-cream]

4. Listening comprehension: Listening comprehension task

4a. 『後日就係妹妹嘅生日』呢句嘅意思係：

“The day after tomorrow will be my sister’s birthday” means that:

1. 聽日係妹妹嘅生日

Tomorrow will be my sister’s birthday

2. 仲有兩日先至係妹妹嘅生日

There are two days left until my sister’s birthday

3. 今日係妹妹嘅生日

Today is my sister’s birthday

4b. 『小王子好勇敢，單獨去對付大魔頭』呢句嘅意思係：

“The little prince was very brave, he fought the monster alone” means that:

1. 小王子唔怕危險，一個人去對付大魔頭

The little prince was not afraid of danger, he fought the monster on his own

2. 小王子為咗救公主，去城堡搵大魔頭

To save the princess, the little prince went to the castle to find the monster.

3. 小王子冇去救公主

The little prince did not save the princess

5. Syntactic skills: Oral cloze task

5a. 我最喜歡的食物是 \_\_。  
My favourite food is \_\_\_\_.

5b. 海裡有些 \_\_ 在游來游去。  
There are some \_\_\_\_ swimming in the sea.

6. Word Writing Ability: Chinese word spelling

身體 [san1 tai2/body]

開心 [hoi1 sam1/happy]

7. Sentence comprehension task

7a. 我 \_ \_ 做個好孩子。

I am \_\_\_\_\_ to be a good child.

A. 疑問 [questioned]

B. 決心 [determined]

C. 加重 [emphasized]

D. 表明 [declared]

7b. 表姐糾正我的 \_ \_ 。

My cousin corrects my \_\_\_\_\_.

A. 錯誤 [mistake]

B. 標誌 [symbol]

C. 協助 [assistance]

D. 好奇 [curiosity]

8. Passage comprehension task

昨天，爸爸、媽媽、小慧表妹和我一起到動物園遊玩。動物園裡有兩隻猴子，分別叫玲玲和明明。當玲玲在籠子正準備吃香蕉時，突然聽到有人叫牠的名字，舉頭一看，手中的香蕉就消失了。玲玲發現後，著急地大叫，到處找牠的香蕉。

籠子外的明明則在哈哈大笑，還不停地跳來跳去，而牠身旁的草地上就有一隻香蕉。這時小慧對我說：「明明真是壞，自己不吃，也不讓別人吃。」

Yesterday, daddy, mummy, Siu Wai and I visited the zoo together. There were two

What skills make a difference in reading Chinese 38  
monkeys, whose names were Ling Ling and Ming Ming, in the zoo. When Ling Ling was about to eat its banana in the cage, someone called its name. But the banana was gone before its eyes while it looked up. After Ling Ling found this out, it shouted anxiously and searched for its banana everywhere.

Ming Ming was cachinnating and scampering outside the cage. Besides it, there was a banana on the ground. Siu Wai said to me, "Ming Ming is so bad. It won't let the others have the banana even it doesn't want it."

- 8a. 玲玲的香蕉不見了，是因為\_\_\_\_\_。  
Ling Ling's banana was gone because \_\_\_\_\_.
- |                     |                            |                         |
|---------------------|----------------------------|-------------------------|
| A. 香蕉自己消失了          | B. 牠把香蕉吃掉了                 | C. 被另一隻猴子偷了             |
| The banana vanished | It has eaten the banana up | Another monkey stole it |
- 8b. 籠子外，明明的心情是怎樣？  
Outside the cage, how did Ming Ming feel?
- |          |         |           |
|----------|---------|-----------|
| A. 幸福    | B. 興奮   | C. 痛苦     |
| Blissful | Excited | Miserable |
- 8c. 小慧對明明的評語是牠很\_\_\_\_\_。  
Siu Wai commented that Ming Ming was very \_\_\_\_\_.
- |         |         |           |
|---------|---------|-----------|
| A. 頑皮   | B. 古怪   | C. 活潑     |
| Naughty | Strange | Energetic |

Table 1

*Reliabilities, Means, Standard Deviations and Ranges for Measures in the Present Study*

Variable	Reliability coefficient	Mean	SD	Range
Age (in months)		79.16	3.76	73 - 90
IQ		110.35	14.104	65 - 135
Oral Vocabulary	.96	13.49	4.15	2 - 27
Phonological Awareness	.51	7.34	2.18	2 - 12
Rapid Naming	.89	23.38	5.41	13 - 40
Orthographic Skills	.66	9.91	2.97	2 - 16
Morphological Awareness	.65	11.22	2.58	4 - 15
Listening Comprehension	.38	7.29	1.84	3 - 12
Syntactic Skills	.61	23.61	3.62	11 - 30
Word Reading	s	71.28	27.33	0 - 136
Word Spelling	.83	11.34	5.01	0 - 22
Sentence Comprehension	.74	7.97	2.64	1 - 12
Passage Comprehension	.78	5.80	1.95	1 - 9

*Note.* Inter-rater reliability coefficient was computed for oral vocabulary. Cronbach's alpha coefficients were computed for phonological awareness, rapid naming, orthographic skills, morphological awareness, listening comprehension, syntactic skills, word spelling, sentence comprehension and passage comprehension. s: Standardized measure with good reported reliability.

Table 2

*Correlations Among Age, Oral Vocabulary, Phonological Awareness, Rapid Naming, Orthographic Skills, Morphological Awareness, Listening Comprehension, Syntactic Skills, Word Reading, Word Spelling, Sentence Comprehension and Passage Comprehension*

	Age	IQ	OV	PA	RAN	OS	MA	LC	SS	WR	SP	SC	PC
Age	-												
IQ	-0.04	-											
OV	0.11	0.12*	-										
PA	0.12	0.14*	-0.12	-									
RAN	-0.03	-0.11	0.08	-0.23***	-								
OS	0.14*	0.39***	0.10	0.18**	-0.23***	-							
MA	0.04	0.38***	0.05	0.21***	-0.25***	0.43***	-						
LC	-0.03	0.25***	0.04	0.15*	-0.17**	0.21***	0.30***	-					
SS	0.07	0.17**	0.10	0.03	-0.19**	0.29***	0.25***	0.21***	-				
WR	0.05	0.33***	0.04	0.21***	-0.47***	0.48***	0.48***	0.30***	0.29***	-			
SP	0.02	0.22***	0.05	0.21***	-0.30***	0.35***	0.48***	0.31***	0.27***	0.55***	-		
SC	0.07	0.32***	0.02	0.14*	-0.36***	0.50***	0.42***	0.24***	0.35***	0.75***	0.44***	-	
PC	0.14*	0.37***	0.02	0.15*	-0.34***	0.40***	0.39***	0.27***	0.36***	0.57***	0.42***	0.54***	-

*Note.* OV, Oral Vocabulary; PA, phonological awareness; RAN, rapid naming; OS, orthographic skills; MA, morphological awareness; LC, listening comprehension; SS, syntactic skills; WR, word reading; SP, word spelling; SC, sentence comprehension; PC, passage comprehension.

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



Table 3

*Standardized Betas for Regression Equations Predicting Word Reading and Word Spelling From Reading-related Skills Measures After Controls for Differences in Age, IQ and Oral Vocabulary*

Final step predictor	Word reading			Word spelling		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
Age	-0.02	0.33	0.00	-0.06	0.07	-0.04
IQ	0.14	0.10	0.07	-0.01	0.02	-0.02
Oral Vocabulary	-0.03	.031	-0.01	0.03	0.06	0.02
Phonological Awareness	0.04	0.60	0.00	0.22	0.12	0.10
Rapid Naming	-1.70	0.24	-0.34***	-0.15	0.05	-0.16**
Orthographic Skills	2.63	0.49	0.29***	0.25	0.10	0.15*
Morphological Awareness	2.64	0.57	0.25***	0.70	0.12	0.36***

*Note.*

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

Table 4

*Unique and Common Contributions of Age, IQ & Oral Vocabulary, Orthographic Skills, and Morphological Awareness to Word Reading and Word Spelling*

	Word Reading	Word Spelling
Unique contributions		
1. Age, IQ & Oral Vocabulary	0.025	0.020
2. Orthographic Skills	0.097	0.027
3. Morphological Awareness	0.065	0.132
Common contributions		
Common to 1 and 2	0.005	-0.001
Common to 1 and 3	0.085	0.062
Common to 2 and 3	0.023	0.001
Common to 1, 2 and 3	0.069	0.039
Sum	0.369	0.280

Table 5

*Standardized Betas for Regression Equations Predicting Sentence Comprehension and Passage Comprehension From Reading-related Skills Measures After Controls for Differences in Age, IQ, Oral Vocabulary and Word Reading*

Final step predictor	Sentence Comprehension			Passage Comprehension		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
Age	0.01	0.03	0.01	0.06	0.03	0.11*
IQ	0.01	0.01	0.06	0.02	0.01	0.16**
Oral Vocabulary	-0.01	0.03	-0.01	-0.01	0.02	-0.01
Word Reading	0.06	0.01	0.60***	0.03	0.01	0.36***
Phonological Awareness	-0.05	0.05	-0.04	-0.05	0.04	-0.05
Rapid Naming	-0.02	0.02	-0.04	-0.04	0.02	-0.11*
Orthographic Skills	0.12	0.04	0.14**	0.04	0.04	0.06
Morphological Awareness	0.03	0.05	0.03	0.03	0.04	0.04
Listening Comprehension	0.01	0.06	0.01	0.07	0.05	0.07
Syntactic Skills	0.07	0.03	0.10*	0.09	0.03	0.16**

*Note.*

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

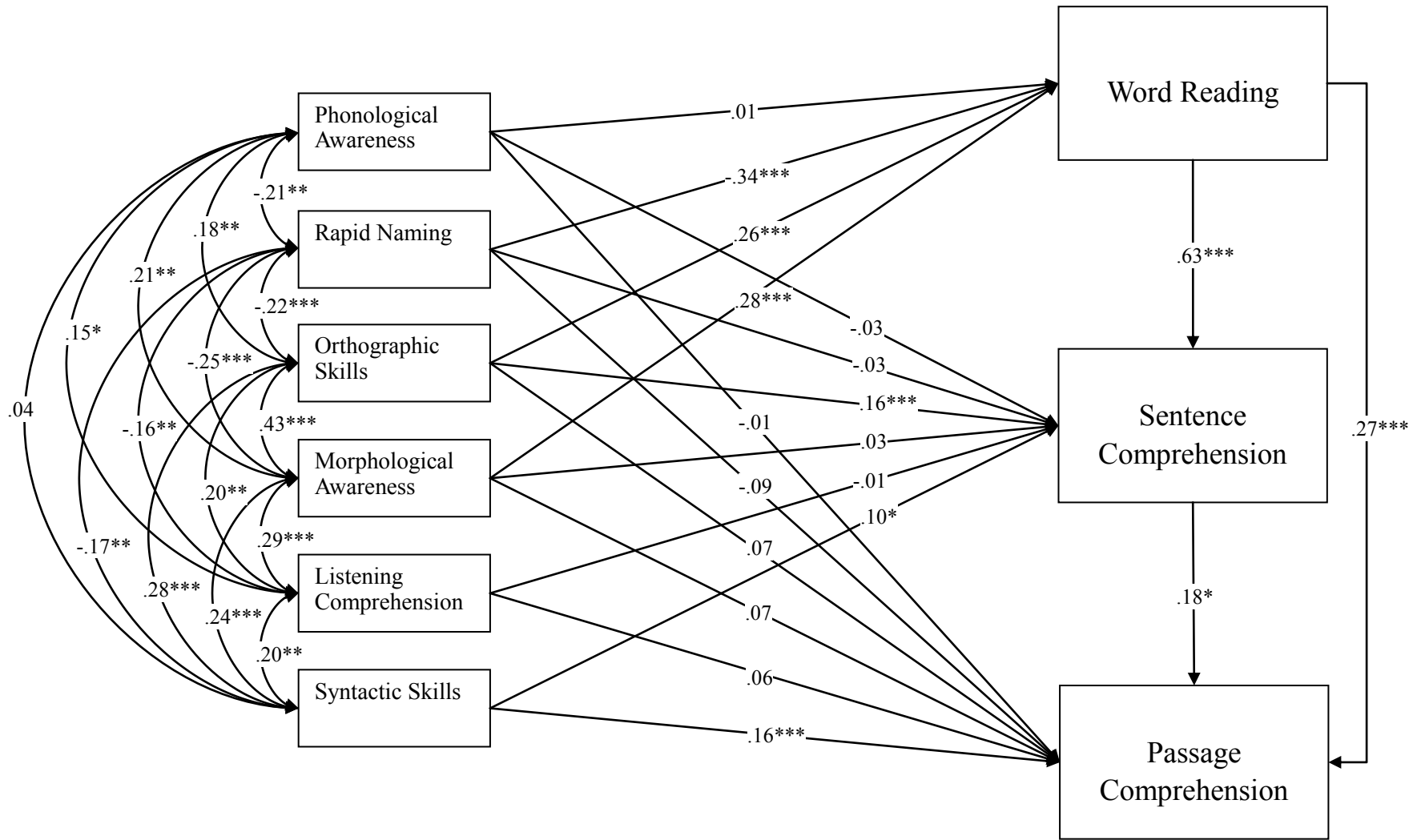


Figure 1. Model 1 of Reading in Chinese. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

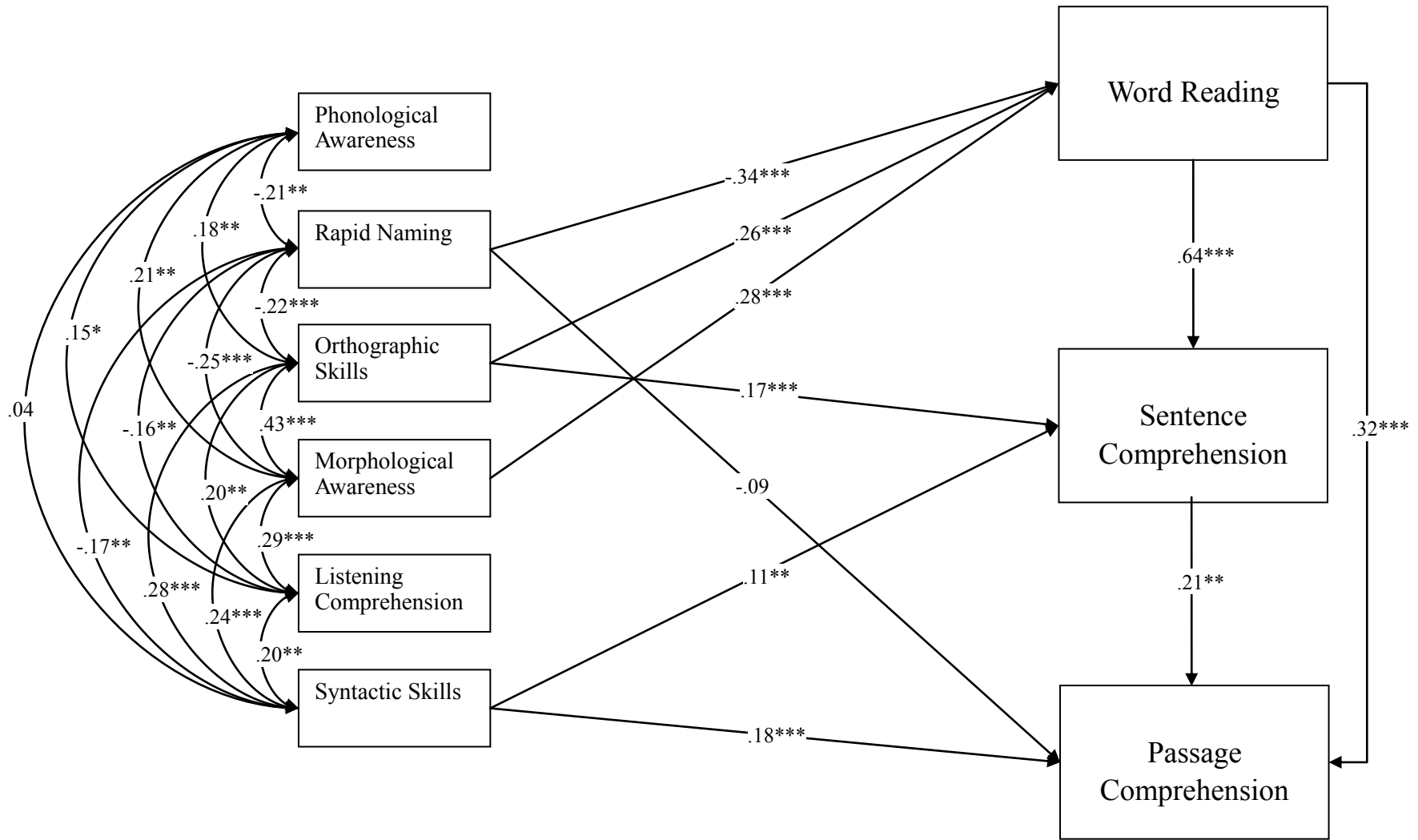


Figure 2. Model 2 of Reading in Chinese. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .