COMPARISONS OF THE INFLUENCE OF PHONOLOGICAL AND MORPHOLOGICAL PROCESSING ON CHINESE READING DEVELOPMENT: A CROSS-SECTIONAL AND LONGITUDINAL STUDY

by

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Abstract

The underlying rationale behind alphabetic orthographies is that graphemes roughly correspond to phonemes. However, in the Chinese writing system, the basic unit is a character that usually represents one syllable and corresponds to one morpheme. Given that phonological awareness plays a central role in reading acquisition for alphabets that follow regular grapheme-phoneme correspondence rules, it seems likely that morphological awareness should be more important for learning to read scripts in which the mappings between orthography and meaning are often systematic. Such fundamental differences in the orthographies may have significant implications for the way written words are recognized and, hence, the way reading is acquired. In mainland China, children learn Chinese characters through being taught the more alphabetic script of Pinyin. It is, therefore, likely that the Pinyin system, as well as the Chinese characters system, will influence reading development. Therefore, a complex relationship between reading, phonological and morphological processing may be predicted, with the influence of the latter two on the former varying with development – as Pinyin becomes less important for decoding, phonological influences may be superseded by morphological.

The present research investigated the early development of Chinese reading skills to assess potential changes in phonological and morphological influences. Measures of reading Pinyin and Chinese characters were given to children in primary-level school grades in Mainland China. Over the course of the study, grades 1 to 5 were assessed with about 50 children in each grade tested. Measures of word and non-word reading, as well as reading comprehension were used. In addition, a range of phonological and morphological tasks were developed, and these were contrasted with Chinese vocabulary and rapid naming, to measure the potential impact of these language skills on Chinese reading. Cross-sectional and longitudinal analyses were conducted to assess such impacts.

Both cross-sectional and longitudinal data indicated a change in relationships across grades such that early phonological predictors of Chinese character and text reading were replaced by morphological processing skills and measures of rapid naming. The results argue that phonological awareness plays an important role in reading acquisition at the beginning of acquisition for these Mainland Chinese students, whereas morphological processing is more important for intermediate and upper graders in later stages of reading development. These findings are discussed in relation to current general models of reading and specific influences of orthography, as well as the context of literacy learning within Mainland China.

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Chapter 1

Introduction

Reading is considered a fundamental tool for success not only in educational areas, but also for social and economic success in life. Adam (1990) indicated that reading is a reliable predictor for children to succeed in school and become productive members of society. The importance of reading can be evidenced by consideration of those who struggle with reading. Specific learning disabilities that lead to problems with acquiring literacy (sometimes called dyslexia) have an estimated prevalence rate of around 4% of the school population around the world (Smythe et al., 2004) – although these rates can vary depending on assessment procedures. For example, Shaywitz et al. (1998) argued that in English-speaking countries as many as 12% to 17% of school children may show evidence of developmental dyslexia. In contrast Chinese has long been believed to be immune from dyslexia. However, comparable incidence rates of reading disabilities among American, Japanese and Chinese children have been identified (Stevenson et al., 1982). Other studies have also demonstrated the similar prevalence of reading disabilities in Chinese speaking children in Mainland China (Zhang et al. 1996) and in Hong Kong (e.g., Yeung, 1982), as well as in Vancouver (Kline & Lee, 1972). Data from different countries suggest that reading difficulties can have far reaching effects on the individual's success in education and employment, as well as their well-being in society (Miles & Varma, 1995; Smythe & Everatt, 2004; Snowling, 2000). In fact, the National Institutes of Health in the U.S. classifies reading and related learning disabilities as a major challenge to public health and societal welfare. There may be a high societal cost of undetected and untreated literacy learning disabilities worldwide. Most current tools to support children with literacy learning problems have been developed for the English-speaking child. However, learning to read and write in one language is not necessarily the same as in another. Underlying factors related to literacy learning difficulties may vary between orthographies and aspects of the language or culture within which an individual is immersed may make a support tool inappropriate within some contexts. (See discussions in: Everatt et al., 2000; Goswami, 2000; Katz & Frost, 1992; Leong & Joshi, 1997; Smythe et al., 2004).

Work across many contexts has shown that literacy learning difficulties are related to language processes; in particular, the processing and/or storage of phonological forms (for a review, see Goswami, 2000). Frost (1998) proposed the strong phonological theory in which core lexical representations that underpin visual word recognition are phonological, and thus, that phonological processing is a mandatory part of the recognition process. Following this trend, the central role of phonology in reading development, reading disability and reading remediation has been researched across the world's writing systems. A large body of studies (Gillon, 2004; Goswami, 2000; Goulandris, 2003; Snowling, 2000; Stanovich, 1988) have affirmed the importance of phonological processing and its relationship to reading, indicating that phonological processes are predictive of reading and spelling levels amongst many language groups and that those with poor literacy levels show weak phonological decoding and low levels of phonological awareness in comparison to matched average-to-good readers/writers.

The pattern of inter-relationships between literacy and phonological awareness is consistent with conclusions derived from English speaking cohorts, suggesting that models of literacy and specific literacy difficulties based on English language data may be appropriate for application to many language contexts. However, English has a relatively inconsistent/complex orthography-phonology relationship in contrast to many other orthographies and this variation in transparency of the orthography has been found in previous cross-language studies to affect the relationship between literacy acquisition and phonological awareness (Everatt et al., 2004). The degree of transparency between letters and sounds has been found to influence the rate of acquisition of word decoding (Seymour et al., 2003), which may also influence the ability of phonological decoding measures to identify those with weak literacy skills. For example, in contrast to the complex relationship between written symbols and language sounds in English, Hungarian has a highly consistent relationship between letters and sounds, such that a sound can easily be derived from identification of a known letter and vice versa. Smythe et al. (2008) found that when these two languages were contrasted, measures of phonological decoding were less reliable predictors of word-level literacy weaknesses amongst Hungarian children than amongst English children. This same low-level prediction was found by these researchers when testing children learning to read Chinese characters. These findings lead the authors to conclude that the level of transparency of orthography affected the centrality of phonology in reading.They further speculated that an awareness of morphology may better support reading processes in some orthographies. Interestingly, Frost (2012) also proposed a new universal theory of reading which put morphology at the heart of the reading process. This new universal model, which highlights the potential importance of morphemically based visual word recognition, inspired an enhanced focus on the role of morphological processing in reading. Actually, morphological awareness, defined as the conscious awareness of the morphemic structure of words, has been reported to be important in several language contexts such as Arabic, Hebrew, and Hungarian (for a review, see Smythe et al., 2004).

However, a universal model should take into account the phonology and morphology that orthographies represent. If a writing system aims to provide morphological information, morphology may take the precedence over phonological representations in word recognition, whereas if orthographies aim to provide phonological information, then phonology is more likely to be at the heart of reading process. The current study investigates such possibilities by comparing the influences of morphological and phonological processing in Chinese reading development. This context should be informative about such influences since learning to read in Mainland China (the context of the current research) comprises the acquisition of a more alphabetic, or phonological-based, script (pinyin) as well as the more logographic, or morphological-based, Chinese characters. The insights gained by considering development in this context, thus should inform universal theories of learning to read.

As stated above, there are two written representations of Chinese that children are expected to acquire: the more alphabetic-form of the pin-yin script and the Chinese character orthography, which uses a large number of symbols to represent concepts. The pin-yin script is more transparent than English, though there are inconsistencies that make it less transparent than Hungarian, for example. Hence, it may be more difficult to identify underlying decoding-related phonological weaknesses in pin-yin readers as it is in learners of other relatively more transparent scripts. Similarly, measures of rate of reading have been argued to be better indicators of variance in reading levels than measures of reading accuracy often used in English tests (see Wimmer, 1993), with measures of phonological fluency (such as rapid naming tasks) potentially being better predictors of these reading levels than measures of accuracy in phonological tasks (see Landerl et al., 1997). The Chinese-character orthography has a very different relationship between individual written symbols and language sounds than that found in scripts which follow the alphabetic principle of basic sounds being represented by letter symbols; indeed, Chinese characters were designed to represent morphemes rather than phonemes. Again, it might be expected that relationships between different measures of phonological decoding skills and word level literacy will vary from those found in English language studies due to this difference in the way language is represented by the script. Thus, although phonological processing has been found to be predictive of reading in Chinese-language children (e.g., McBride-Chang et al., 2005), measures related to morphological awareness may be as important a predictor of reading Chinese characters. Hence, the identification of the specific relationship between Chinese literacy acquisition and phonological processing skills and morphological processing requires further research.

The present research, therefore, aims to re-examine the centrality of phonological and/or morphological processing on reading development by studying Chinese language children learning to read in mainland China. Studying literacy acquisition in Chinese provides a salient contrast to studying alphabetic systems due to the morphsyllabic and non-alphabetic characteristics of written Chinese. The connection between written and spoken language has been considered in the English-language literature primarily from a focus on alphabetic-phonetic components. Since the Chinese character is more like a logograph than a letter string, Chinese studies of these connections open up a new dimension for the understanding of the links between written and spoken language. Furthermore, the influence of rapid naming will be considered given that this might be expected to influence reading development in a relatively more transparent script such as pinyin. However, the extent to which this transparency effect is influenced by the need to also learn a more logographic script is also worth considering. Again, the insights gained from studying Chinese acquisition can enhance our understanding of the universal and unique processes of learning to read across languages.

Additionally, given that a great deal of research on Chinese reading development reported in the English language literature has come from Hong Kong where children are generally taught to read Chinese characters based on rote memory without any phonetic tools, it is possible that different instructional methods between mainland China and Hong Kong (as well as differences in scripts experienced) result in different cognitive processing skills that might be vital for children to achieve reading success at the early stage of Chinese reading development. Rote learning may increase the influence of processes such as rapid naming, whereas learning a more alphabetic script may reduce this influence. Hence, research findings derived from studies in Hong Kong may not be representative of mainland China, and more research on children's reading development in the context of teaching in mainland China would be useful to confirm or refine current perspectives on Chinese reading acquisition.

The research was designed based on the view that reading development will be related to learning and experience, and may therefore proceed through a series of stages/phases related to the cognitive development of the child and instructional factors . Evidence from studies of English word reading suggests that there are a series of stages that children go through when learning to read (see examples in Frith, 1985, and Ehri, 1994). Findings from studies on Chinese also suggest that Chinese word reading includes a developmental shift from a visual stage to a phonological stage, which is similar to what emerges in English word reading development (see Ho & Bryant, 1997). Therefore, relationships between reading-related cognitive skills and word reading or reading comprehension may rely on children progressing through these developmental levels or stages. Though equally, these relationships could be influenced by the type of teaching, or reading experiences, provided at different grade levels. Either way, relationships between reading levels and cognitive skills may be expected to vary with age and/or grade. Hence, the current research investigates these relationships across grades through cross-sectional and longitudinal procedures.

This dissertation contains six chapters. The following chapter initially provides a review of the research in terms of the role of phonological processing, morphological processing and rapid naming speed on reading acquisition in alphabetic languages. The Chinese context is then discussed, including a consideration of the Chinese language and its orthography, phonology and morphology, as well as a consideration of literacy education practices in Mainland China and Hong Kong. This is followed by a discussion of research examining the influence of phonological awareness, morphological processing and rapid naming speed on Chinese reading acquisition. Finally, the rationale and questions of the present research are articulated.

Chapter three reports study 1 in which a cross-sectional design was used to assess cohorts of children from grades one, two and four. Children's cognitive skills involving phonological processing, morphological processing, RAN skills, and reading skills including pinyin and character reading were assessed. The correlations between these variables were obtained and unique variability of each construct in Chinese reading was examined. The results indicated that measures of phonological processing were the larger predictor of Chinese character reading in the early grades (grade 1 and 2), but this had changed to morphological processing by grade 4. In these data, there was a clear pattern across the regression analyses for phonology to be the largest predictor in grade 1. In contrast, morphology was the larger predictor by grade 4. Interestingly, grade 2 data seemed to show something of a transition in that phonological and morphological measures explained roughly equal amounts of Chinese character reading variance (phonological measures were only slightly larger than morphology-based measures), with rapid naming explaining the least amount of variance, though this was only slightly less than the morphology measures. (i.e., in grade 2, all three areas of processing may influence Chinese character reader to roughly similar extents).

Chapter four reports study 2 where the children's cognitive processing skills and reading ability were re-tested one year later to allow the research to show the hypothesized changes in influences within the same children. In phase 2 of the research, the measures covered the same range of skills areas, but comprised a selection of measures chosen from the first phase. In addition, the reading measures were extended to include reading comprehension, which is of central component to reading. This second study showed a similar pattern to that found in study 1. The phonological and morphological measures explained roughly equal amounts of variance for grade 2 children, but morphology was the larger predictor for grade 3 and 5 students. Rapid naming predicted the least amount of variability up to grade 5, when it explained larger variance than the phonological measures. This pattern seemed to be followed for reading comprehension when phonology and morphology measures were considered: phonological measures were the better predictors in grade 2, but morphological measures were the larger predictors in grades 3 and 5. Rapid naming, however, was almost as large a predictor of reading comprehension as morphology in grade 3 and was the larger predictor by grade 5.

Chapter five reports analyses considering longitudinal relationships between cognitive skills assessed in phase 1 and reading outcomes measured in phase 2. The value of early phonological awareness, morphological awareness, and rapid naming (RAN) in predicting subsequent literacy development in Chinese was thus investigated. The results indicated that the longitudinal analyses were, in the main, consistent with the time 1 and 2 data. Phonology in grade 1 predicted the largest amounts of variability in character reading in grade 2. Phonology and morphology in grade 2 predicted reasonably large amounts of character reading in grade 3, with phonology showing the largest level of variability predicted. However, morphology in grade 4 was the largest predictor of character reading variability in grade 5; with phonology and rapid naming showing similar levels of prediction from grade 4 to 5. For reading comprehension, phonological processing in grade 1 was the largest predictor of grade 2 variability and showed almost equal levels of variability predicted as the morphology measures. Grade 4 measures of morphology and rapid naming were the larger predictors of reading comprehension in grade 5 – though with the former being potentially larger than the latter.

Chapter six presents a general discussion of the findings, together with the conclusions derived from the research. The developmental pattern of reading acquisition in Chinese was discussed from a cross-sectional and longitudinal perspective, and a developmental model of literacy was produced based on the current findings and other available research, which should form the basis on which to inform further development of universal models of reading.

Although the primary aim of the current research was to inform models of Chinese reading acquisition, and hence general models of literacy development, the work has some relatively unique elements that differentiate it from the current body of work on Chinese discussed in the literature review. Few previous studies have developed the range of measures used in the current work to assess reading, phonological processing, morphological awareness and rapid naming. Phonological processing, in particular, was assessed across a range of processes/levels through the development of nine different measures that examined different aspects of the construct. The phonological awareness measures covered syllable and onset-rime tasks, tone based and phoneme level skills using measures of deletion, discrimination and production. By including this range of phonological processing, from syllable to individual phonemes, the current study provided an extensive set of data to explore the role of phonological processing in Chinese reading development. Similarly, a range of measures of morphological awareness and rapid naming were also included. Morphological awareness was assessed by five measures which were designed to examine the children's compound awareness at the word level and morphological structure awareness. Rapid naming was assessed by four tasks that included naming of objects, digits, pinyin letters or simple Chinese characters. This range of measures was used to provide a comprehensive assessment of these areas of processing. If such areas of processing were involved in Chinese reading, then this range of tasks has a high likelihood of finding relationships with reading skills consistent with their involvement, as well as of dissociating effects on reading across those areas.

Consistent with the aim of providing a range of measures of processing skills, the study also incorporated a range of reading tasks. Chinese reading abilities were assessed by Pinyin reading, Chinese character reading and a reading comprehension task. The assessment of a range of cognitive and reading skills increased the chance of identifying relationships (as argued in the previous paragraph), but also provided the potential to examine whether different underlying processes played different roles across different types of reading skills. Again, the aim of the present research was to provide a broader set of data on the target variables than provided by existing studies, through which to inform theory and practice. Surprisingly, few studies (particularly reported in the English language literature) have considered the involvement of Pinyin reading and its potential influence on the relationships between phonological, morphological and naming processes and literacy development. The present study specifically included measures of reading in Pinyin and in Chinese characters to investigate evidence for differences in the underlying processes that support logographic-based (Chinese character) and alphabetic-based script (Pinyin) literacy acquisition in one language (i.e., Chinese).

Another feature of the research was a focus on early development of reading skills through its assessment of year one children and following their development through to year two. Few studies have focused on children learning to read in Chinese in the early stages of formal literacy development. However, the work also considered reading levels in older children (year 4 going on to year 5) to inform theoretical perspectives about reading in the more advanced years, and to allow the future development of links between early years and later skills. The current research was not able to follow students over four years of development (a time period impracticable for a three-year PhD), but it does offer ideas and data that should be informative for such research programmes. The present work focused on years 1 and 2 of early literacy acquisition, then followed these groups into a subsequent year of school to investigate potential developmental changes within the same children. A group of year two students in both stages of data collection also provided the opportunity to assess the consistency of findings across longitudinal and cross-sectional parts of the work. The year 4 children who moved onto year 5 during the research provided the current research with data across the first five years of literacy learning, thereby producing findings across a range of years in which the pattern of relationships between Chinese reading ability and underlying cognitive processes could be assessed.

Overall, by assessing children with multiple cognitive and reading skill measures across a range of primary school year levels that include the first year of school-based learning, the research will increase our understanding of the contributions of phonological, morphological and naming processing skills to Chinese reading development. This will inform current models of literacy acquisition in Chinese and provide data that can support teaching practices.

Chapter 2

Literature Review

Reading acquisition across languages

Compared with the acquisition of spoken language, reading is a learnt skill that requires the combination of various perceptual and cognitive processes. There are numerous factors involved in the acquisition of reading . It seems logically plausible that failure in any one will result in reduced effectiveness in reading acquisition. A focus of much of the research on reading and reading acquisition over the last thirty years or more (see Adams, 1990; Perfetti, 1985) has been the importance of individual word recognition. Reading comprehension has been found to depend on how well individual words in a text are recognized (Juel, Griffith & Gough, 1986; Stanovich, 1984; Tunmer, Herriman & Nesdale, 1988; Tunmer & Nesdale, 1985). Gough and Juel (1991) stated that it is essential to ensure children learn to decode when they start to read. They summarized "*poor decoding skill leads to little reading and little opportunity to increase one's basic vocabulary and knowledge, leaving a shaky foundation for later reading comprehension*" (p.55). Although reading entails more than word recognition (Massaro & Cohen, 1994), word-decoding is a vital component of successful reading acquisition, especially at the beginning stages of learning to read.

Of course, sufficient word recognition ability does not guarantee good comprehension. However, as stated by Stanovich (1984), "*word recognition is the foundational process of reading*" (p. 418). Without good word recognition, adequate reading comprehension may never be attained. A number of studies have shown consistently that word recognition levels are strongly correlated with the pace of early literacy acquisition (Juel, Griffith & Gough, 1986; Perfetti, 1985). There is also evidence that the skill of word recognition is causally related to reading comprehension ability and accounts for significant variance in reading ability among adult readers (Share & Stanovich, 1995). Juel, Griffith & Gough (1986) reported that word recognition proficiency explains substantial unique variance in reading comprehension even after the effect of listening comprehension, as a measure of spoken language understanding, is taken into account. Furthermore, skilled and less-skilled readers can be classified according to their performance on standardised word recognition tests.

Theoretical Model for Reading Comprehension

The ultimate goal of reading is to comprehend the concepts described in a text (Stanovich, 2000). Although learning to read is a complex process, reading comprehension can be viewed as a function of the outcome of two component skills: decoding (i.e., word recognition), and linguistic comprehension (Gough & Tunmer, 1986). The "simple view of reading" proposed by Gough and Tunmer (1986) assumes that reading equals the product of these two components. Decoding refers to efficient word recognition, which in turn, depends fundamentally on knowledge of letter-sound correspondence. Linguistic comprehension refers to the interpretation process of sentence and discourse upon the lexical information extracted by decoding. The assumption is that both word recognition and linguistic comprehension are necessary for extracting meaning from written material.

Efficient decoding is important for reading comprehension. Skilled readers are usually good decoders: they recognize words swiftly and accurately when reading through the text. It should be noted that the word recognition process occurs almost automatically, fluently, and rapidly enough to allow the reader to attend to meaning in text. Children who cannot develop automatic word recognition will have difficulties comprehending the meaning of the text. Hence, reading comprehension is dependent on good word recognition skills (Seidenberg, 1992).

It is common to say that an alphabetic orthography, like English, is indeed a code and the process of reading acquisition can be considered as a process of code-breaking (Gough et al., 1992). Moreover, research findings suggest that decoding measures correlate moderately to highly with more global reading measures, such as comprehension measures (Tunmer & Hoover, 1993) and decoding is a major contributing variable to reading comprehension (Stanovich, Cunningham, & Feeman, 1984). The ability to read nonwords (or pseudowords) at all ages is one of the most reliable predictors of word recognition skills (Leong, 1993; Wagner & Torgesen, 1987).

The "simple view of reading" assumes that word recognition plays a necessary role in mastery of reading. However, reading cannot be equated with word recognition. Decoding is a necessary, but not sufficient condition for reading. Linguistic comprehension ability also is required for efficient reading. Given adequate decoding skill, reading for meaning relies primarily on proficient linguistic comprehension ability. To understand what they are reading, good readers make use of their background knowledge of the world and their knowledge of oral language structure and function to help them grasp the written word's meaning. Thus, comprehending a text requires the integration of different skills/processes, starting with lower level word-level processes and proceeding to higher linguistic comprehension skills, which involve vocabulary knowledge, syntactic parsing and inference processing (Tunmer & Hoover, 1992).

Syntactic parsing is the process by which the extracted lexical information is acuminated and integrated to reflect the meaning of word strings and support clause-level meaning (Koda, 2005). Syntactic processing involves an understanding of the rules of grammar and an ability to manipulate the grammatical structure of sentences in a language (Gombert, 1992). The process includes identifying phrase structure, assigning case roles to the structure, and recognizing subordinate and super-ordinate relations among clauses. The word meanings and structural information are then combined into basic clause-level meaning units. As argued by

Gough and Tunmer (1986), children who have syntactic deficits are likely to have poor understanding of connected texts because they cannot work out the complex clausal structures.

Inference generation is the core cognitive skill of reading comprehension, and is affected by the readers' working-memory capacity and background knowledge (Koda, 2005). Studies have found that differences in working-memory capacity were related with inference-generalization performance (Carpenter, Miyake & Just, 1994). The readers' domain knowledge of the text's content, which helps interpreting and integrating the text information, was also found to be related to comprehension performance (Kintsch, 1994).

Additionally, the size and depth of vocabulary knowledge has been found consistently to be highly related to measures of reading comprehension. However, though the link between vocabulary knowledge and reading comprehension has long been recognized, the relationship is reciprocal in nature. More research is called for to determine if vocabulary is the cause for reading performance (Koda, 2005).

Research findings suggest that measures of word recognition (decoding) and linguistic comprehension could account for a substantial variance in reading comprehension ability in alphabetic and non-alphabetic languages. Joshi et al. (2012) found that the simple view of reading is applicable to writing systems other than English. In that study, Spanish, with transparent orthography, English, with less transparent orthography, and Chinese, with opaque orthography, were selected because of their diverse characteristics. Multiple regression analysis showed that a large amount of variance in reading comprehension of Spanish, English and Chinese participants was explained by decoding and listening comprehension, even though decoding explained less variance in Spanish compared to English and Chinese. These results indicate that the simple view of reading is applicable across language/orthography.

Evidence has also indicated that the contribution of word reading (or decoding) and language (linguistic) comprehension in promoting reading comprehension varies across language/orthography potentially due to the transparency of the orthography learnt by the individual (Florit & Cain, 2011). Florit and Cain (2011) conducted a meta-analysis of 33 studies across a range of languages varying in orthographic transparency, including English which is considered as one of the least transparent (or more opaque) orthographies. In contrast to the findings for English readers, early learners of a more transparent orthography showed a greater influence of language comprehension than decoding accuracy (though not decoding fluency) on reading comprehension. The authors attributed this effect to the relatively rapid rate of decoding acquisition in readers of more transparent orthographies. This argument is supported by recent findings that suggested the stronger role of language comprehension than decoding accuracy in predicting reading comprehension throughout primary school years for transparent orthographies (Tobia& Bonifacci., 2015). In contrast, decoding accuracy for readers of English was found to be more important than language comprehension in the early stages of reading, and remained influential after 3 to 5 years of reading instruction, consistent with arguments that decoding skills in English develop more slowly than with more transparent orthographies (Moll et al., 2014).

Researchers have further examined developmental changes in the relative contributions of word recognition and linguistic comprehension abilities to the variance in reading comprehension. At the early stage of learning to read, the readers' decoding ability has greater influence. Then, linguistic comprehension explains considerably more variance than word recognition at later stages of reading development. The developmental trend was also supported by findings of simple-view studies. Catts et al. (2005) found that the amount of unique variance in reading explained by decoding and linguistic respectively changed across grade levels. The variability explained by linguistic comprehension increased with reading development; while reading variance explained by decoding decreased with age/experience.

Similarly, Neuhaus et al. (2006) found that grade three students' linguistic comprehension accounted for more variance in reading than decoding. These findings suggested that around grade three, a transition from junior to senior primary, may mark the shift of primary contributions from decoding to linguistic comprehension. Overall, simple-view studies depicted a developmental trend of reading comprehension, in which the contribution of decoding decreases and that of linguistic comprehension increases with grade levels.

Cognitive-linguistic skills related to Chinese reading comprehension

In the literature on alphabetic writing systems, it has been found that children's reading comprehension performance is affected by both word-level reading-related skills, such as word reading efficiency and vocabulary knowledge (Tunmer& Hoover, 1992), and text-level processing skills, such as syntactic and discourse skills (Cain, 2007). However, relatively less attention is paid to reading comprehension in Chinese, which has a non-alphabetic orthography. In the current study, cognitive-linguistic skills related to Chinese reading comprehension commonly investigated in past research, including RAN, morphological awareness and syntactic processing will be reviewed.

RAN and Chinese reading comprehension

Research on alphabetic writing systems shows that rapid naming is one of the most significant predictors of the reading comprehension of children (Logan and Schatchneider ,2014). However, among those studies examining the relationships between rapid automatized naming and reading comprehension among Chinese children have, in general, produced equivocal findings about the role of rapid naming as a predictor of reading comprehension in Chinese. For example, Shu et al. (2006) found that RAN had strong relationships with Chinese text comprehension among

Mainland Chinese children in grades 5 and 6. However, Yeung et al. (2013) showed that RAN was not significantly correlated with Chinese reading comprehension among Chinese fourth graders in Hong Kong. In Shu et al. (2006), rapid naming was a significant correlate of reading comprehension in the context of morphological awareness, phonological awareness and vocabulary, but word reading was not controlled. In contrast, in Yeung et al. (2013), rapid naming made little direct contribution to reading comprehension when word reading was controlled. Thus, the authors argue that rapid naming is related to reading comprehension in Chinese through its contribution to word reading. Hence, the specific role of rapid naming as a predictor of reading comprehension in Chinese has yet to be determined clearly, given that relationships with reading comprehension have been found to be variable across studies.

MA and Reading comprehension

Previous studies have shown that morphological awareness is a strong predictor of reading comprehension in alphabetic writing systems (Nagy et al., 2006). Similarly, morphological awareness seems to be one of the strongest correlates of Chinese reading development and impairment. Thus, morphological processing may be taken as significant cognitive construct influencing reading levels among Chinese children. An increasing number of empirical studies have demonstrated the importance of morphological skills in Chinese word reading and children’s ability to distinguish among meanings of homophones, and to perform morphological construction tasks, were found to contribute significantly to word reading levels in Chinese (Yeung et al., 2014).

However, the findings of the effects of morphological skills and knowledge on Chinese reading comprehension are not as consistent as that for word processing. For example, Chung et al. (2013) found that morphological awareness explained significant unique variability in word reading and reading comprehension for both dyslexic readers and age-matched controls, and thus they concluded that a morphological deficit was an important factor that can discriminate Chinese adolescent dyslexic readers and competent readers. In contrast, Yeung et al. (2013) found that morphological awareness was a strong word-level predictor but not a significant predictor of reading comprehension. In that study, it was found that when word reading was controlled, morphological awareness did not significantly contribute to reading comprehension. These findings may suggest that morphological awareness largely contributes to the understanding of text meaning through word meaning. This speculation awaits further investigation.

Syntactic skill and reading comprehension in Chinese

Syntactic awareness, defined as the ability to recognize, apply and manipulate grammatical rules and structures in a language, has been found to be an important cognitive-linguistic variable underlying reading processes in children across different languages (e.g., Cain, 2007; Chik et al., 2012a and 2012b; Siu et al., 2016). Research on syntactic awareness in relation to reading has increasingly been studied in Chinese because the Chinese language is quite different from Indo-European languages in terms of syntax and morphological features.

Research on reading comprehension in Chinese has demonstrated that syntactic awareness was strongly and longitudinally correlated with sentence comprehension as measured by morphosyntactic skill (Chik et al., 2012a) and passage comprehension assessed with conjunction cloze task (Tong et al., 2014). Research has also reported that dyslexic children have poorer syntactic skills than same-age typically developing peers. For example, Chik et al. (2012b) found that Chinese dyslexic children in Grades 4 and 5 performed less well in reading comprehension than their age-matched controls, and dyslexic readers performed significantly worse than their typically developing peers on morphosyntax skills. In other words, in understanding a passage, Chinese dyslexic children tend to rely on word semantic cues rather than paying attention to syntactic interrelationships, such as morphosyntax features among words or sentences.

Furthermore, Siu et al. (2016) contrasted the roles of different facets of syntactic skills in reading comprehension among Chinese children and showed that sentence comprehension relies more on morphosyntactic skills, in contrast to word order skill which were more involved in interpreting passages. These authors concluded that reading comprehension relies on word order and morphosyntactic skill differentially across grades and in comprehension at different levels.

Theoretical models for word recognition

The identification of a word during reading is a complex process, which involves a variety of sources of information, acquisition and coordination of a range of cognitive skills (Barker et al., 1992). Theoretical models have been developed, mainly from work on English language readers, that may explain some of the key processing in word recognition. One of the most influential types of models has been based on dual-route theories (Coltheart, 1978) of word recognition processes. In this view, there are two basic routes to access the meaning of an isolated printed word: a phonological or indirect route, and a visual or direct route. The visual route involves a word being accessed by a hypothetical entry in a mental lexicon (Henderson, 1992). The visual route allows the reader to make a direct association, or link, between the written form and the meaning stored in the reader's memory. Orthographic shapes, letter cues, and the legality of letter patterns may be used to access the orthographic representation from the memory store (Gillon, 2004). Adams (1990) described orthographic processing as the ability to recognize letters, spelling patterns, and whole words effortlessly, automatically, and visually. And consistent with the existence of this route, there is a body of research that supports the position that orthographic processing contributes significantly to reading (Stanovich & West, 1989). The phonological route, on the other hand, involves indirect access to the word lexicon. Here a word is initially broken into letters or letter clusters (called graphemes). These graphemes are then translated into sounds (called phonemes) using grapheme–phoneme correspondence rules. Therefore, this approach can be described as sounding out words based on their component parts. As a result, phonological representations of words are accessed in the lexicon, which allows a pronunciation of the whole word to become available that can allow access to meaning via this verbal (spoken) form.

Most theories of word identification assume that both direct and phonological mediated mechanisms are available to skilled readers. The pathway that is used to read a particular work is influenced by several factors, such as reading skill and the nature of the writing system: how directly and consistently it represents phonological information (Paap & Noel, 1991). Skilled reading is more likely to rely upon the direct route given the written word familiarity that is acquired through reading experience. Similarly, the phonological route is hypothesised to be used when the reader encounters an unfamiliar or low-frequency word, which will occur most often for inexperienced readers. A large number of studies have demonstrated that phonological information plays an important role in word reading. For example, Stanovich (1982) found phonological processing is a primary subskill of word recognition. In addition, the literature also suggests a significant and casual relationship between phonological skills and reading (Wagner & Torgesen, 1987). According to the dual-route model, phonological awareness would only be necessary when the phonological route is used to access the word's meaning. Better understanding of how a word can be broken into smaller parts would facilitate the development of the awareness of how letters map onto sounds (the grapheme-phoneme correspondence rules), which in turn should support the reader to decode the word.

There are alternatives to dual route views about how word recognition is accomplished. For example, connectionist or “parallel distributed processing” models may provide a useful framework in explaining reading development as well as reading disability (Ehri, 2000). Similar to the above, connectionist models emphasize the importance of phonological information to word recognition and some connectionist models can be considered consistent with Ehri’s modified dual-route model and the analogy models, which hold that skilled readers use knowledge about word’s phonological structure to recognize both regular and irregular printed words (see Gillon, 2004). Skilled readers are assumed to access meaning from printed words by connecting orthographic, phonological and semantic information networks – via a process of gradually learned distributed patterns of activity. Therefore, individuals must acquire the ability to make rapid connections between the orthographic and phonological forms of a word to become a fluent reader. Strengthening phonological awareness knowledge should support the use of phonological information in making connections with orthographic and semantic information when learning to read and spell.

Phonological awareness in Alphabetic Language

As suggested above, theoretical models of word recognition, primarily developed from English language studies, assume that phonological decoding and orthographic processing are two essential skills of word recognition. Phonological processing refers to making use of the phonological, or sound, structure of oral language when learning how to decode written language (Adams, 1990; Wagner & Torgesen, 1987). Wagner, Torgesen, Rashotte, Hecht, Barker, Burgess, Donahue and Garon (1997) identified three kinds of phonological processing abilities, namely phonological awareness, phonological memory and phonological naming. Phonological awareness refers to knowledge about the sound structure of words, and the capacity to manipulate sound units within words. Elbeheri and Everatt (2007) described phonological awareness as "*children's ability to reflect process, conceptualize and manipulate the sub-lexical segments of spoken language such as syllables, onset and rimes, and phonemes*" (p. 273). Morais (1991) defined phonological awareness as a special kind of phonological knowledge that refers to conscious representations of phonological properties of words; again, this focus on three levels of sound units: syllabic, intrasyllabic (such as onset and rime), and phonemic units. One school of researchers considers phonological awareness as awareness of phonemic units only (e.g., Tunmer, Herriman & Nesdale, 1988). However, a broader definition of phonological awareness can include awareness of all three levels (Dodd & Gillon, 2001). To explore children's skill at manipulating different level of linguistic units, the latter view of phonological awareness is adopted in the present study; and the term ‘phonemic awareness’ will be used specifically to refer to the awareness of phonemic units.

The role of phonological awareness in promoting literacy in alphabetic languages has been documented in many empirical studies (e.g., Bryant & Goswami, 1987; Morais, Alegria & Content, 1987;Wagner et al., 1997). Children's performance in phonological tasks, such as rhyme or phoneme detection tasks, has been found to be strongly related to success in reading and spelling (Adams, 1990; Goswami & Bryant, 1990; Wagner & Torgesen, 1987). Even with stringent controls for differences in extraneous variables such as intelligence (IQ) and Socio-Economic-Status (SES), these scores still predicted their reading levels over several years (Bradley & Bryant, 1983). Other evidence in support of the significance of phonological awareness in learning to read comes from work showing that in strictly whole-word reading teaching programs, children with better phonological awareness were the more successful readers (Morais et al., 1987). Similarly, training studies in which phonological awareness was taught in the context of reading instruction resulted in significant improvements in reading over that produced by teaching methods that did not incorporate phonological awareness training (e.g., Ball & Blachman, 1988; Hatcher, Hulme, & Ellis, 1994).

As discussed above, phonological awareness can be divided into three levels: syllables, onsets and rimes, and phonemes. Syllabic awareness refers to “*children's* *ability to detect constituent syllables in words*" (Goswami, 1999, p.135); for example, recognising that the word 'sleeping' has two syllables. Onset-rime awareness refers to "*the ability to detect that a single syllable is made up of two units, the onset, which corresponds to any phonemes before the vowel, and the rime, which corresponds to the vowel sound and to any following phonemes*" (Goswami, 1999, p.135). Phonemes are the smallest sounds that signal changes in the meaning of words (e.g., the words tap and top differ by the medial phoneme). It is suggested that phonological awareness progresses from the syllabic level via the onset-rime level to the phonemic level. Children seem to have developed an awareness of syllables and onsets and rimes before they begin learning to read (Goswami, 1999). This reflects development from a global, holistic phonological representation towards a more fine-grained, segmentalized representation of lexical items (Fowler, 1991; Liberman, Shankweiler, Fischer & Carter, 1974; Lonigan, Burgess, Anthony & Barker, 1998). In their study of 135 young children, Liberman et al. (1974) found that half of the five-year-olds tested could segment by syllables but none of them could segment by phonemes. However, by the end of first grade, 90% of the children had mastered syllable segmentation, and 70% succeeded in phoneme segmentation. Subsequent research (e.g., Lonigan et al., 1998) has confirmed that young children manipulate sound units best at the whole word level, followed by the syllable level. Performance on the same type of task was least accurate at the phonemic level. Fowler (1991) has suggested that the developmental progress of phonological awareness could be extended to reflect "*more fundamental changes in phonological representations*" (p. 53). In other words, children's early lexical items are stored or represented in a more holistic manner and these phonological representations of words gradually become fine-grained and segmentalized at the phonemic level.

Phonological awareness deficits in the assessment and intervention of reading problems

Consistent with the discussion in previous sections, there is a considerable body of evidence arguing for an association between developmental dyslexics' phonological awareness deficits and their reading disability. One reason for this might be that dyslexics have difficulties analyzing the sound structure of language, which leads to failure to learn relationships between spellings and sounds – with the failure to master spelling to sound correspondences being the primary source of word recognition problems (Bruck, 1992). Another hypothesis suggests that dyslexics' poor performance in phonological awareness may not be due to a lack of phonological analysis skills, but may instead reflect inaccuracies in the phonological representations of the words that they are asked to analyze (Swan & Goswami, 1997). Two versions of this phonological representation hypothesis are worthy of note. The first suggests that problems in the precise encoding and retrieval of phonological representations of words underlie the deficits of dyslexic children in phonological awareness tasks at all linguistic levels: i.e., at syllabic, onset-rime and phonemic levels. The second version suggests that dyslexics may have problems only in analyzing phonological representations of words at one or more linguistic levels, but not all. Dyslexics may be able to process words at the onset-rime level, but not the phonemic level (Swan & Goswami, 1997), for example. Consistent with this, Bruck (1992) examined the phonological awareness skills of dyslexic children, adults with childhood diagnoses of dyslexia, and good readers at various age levels. The results indicated that dyslexics do not acquire appropriate levels of phoneme awareness, regardless of their age or reading levels, although they eventually acquire appropriate levels of onset-rime awareness. Even adults with fairly high levels of word recognition skills showed phonemic awareness deficits. This study demonstrated the persistence of dyslexics' phonological awareness deficits specifically at the phoneme level of analysis.

As indicated above, a number of studies have shown that training in phonological awareness significantly improves reading ability . For example, Bradley and Bryant (1983) presented one of the most influential studies suggesting a causal relationship between phonological awareness (referred to as sound categorization) and the development of reading skills. They started their longitudinal training study with 400 preschool children aged 4 to 5 and divided these participants into four groups. The first group was trained in phonological awareness alone, the second group was trained in phonological awareness with letter-sound correspondences, the third group was a control which was taught to group words according to semantic categories, while the fourth group received no training. The findings indicated that those participants trained in both phonological awareness and letter-sound correspondences showed the largest improvements in reading skills and these improvements were durable over time. Such findings argue for the benefits of phonological training but also that teaching phonological skills in isolation from reading may be much less effective than when the two are integrated.

Consistent with the findings above, Hatcher, Hulme and Ellis (1994) proposed that "*training in phonological skills in isolation from reading and spelling skills may be much less effective than training that forms explicit links between children's underlying phonological skills and their experiences in learning to read*". In their study, they compared an intervention programme that involved a combination of phonological skills training and reading instruction against training that involved either phonological skills training alone or reading instruction alone. Their results supported the view that training of phonological and reading skills needs to be integrated to be most effective in enhancing reading skills.

Other studies (Wallach & Wallach, 1976; Williams, 1979) have provided further evidence to support the notion that training in phoneme awareness fosters literacy development. Participants in such training programmes have been found to perform significantly better than children in control programmes, particularly in measures of the ability to decode non-words. These studies suggest that training in phonemic awareness promotes reading ability because children are more able to learn the correspondences between phonemic units and letter units.

Phonological awareness in different orthographies

Work across many language contexts has shown that literacy learning difficulties are related to language processes; in particular, the processing and/or storage of phonological forms (Gillon, 2004; Goswami, 2000; Snowling, 2000; Stanovich, 1988). The pattern of inter-relationships between literacy and phonological awareness is consistent with conclusions derived from English speaking cohorts, suggesting that models of literacy based on English language data may be appropriate for application to many language contexts. However, English has a relatively inconsistent/complex orthography-phonology relationship in contrast to many other orthographies and this variation in transparency of the orthography has been found in previous cross-language studies to affect the relationship between literacy acquisition and phonological awareness (Everatt et al., 2004). The degree of transparency between letters and sounds has been found to influence the rate of acquisition of word decoding (Seymour et al., 2003), which may also influence the ability of phonological decoding measures to identify those with weak literacy skills.

In a cross-linguistic comparative study conducted by Everatt et al. (2004) which focused on the assessment of phonological skills amongst English and Hungarian monolingual children with and without literacy deficits and bilingual Filipino children with and without literacy deficits in English. It was found that monolingual English children with poor literacy skills showed characteristic deficits in most areas of phonological ability, whereas the Hungarian counterparts showed little evidence of such difficulties. In contrast to the complex relationship between written symbols and language sounds in English, Hungarian has a highly consistent relationship between letters and sounds, such that a sound can easily be derived from identification of a known letter and vice versa. This led the authors concluded that phonological deficits may lead to literacy difficulties in certain scripts that are orthographically deep, but that this may not be the case in highly transparent scripts. As such, literacy learning can be considered script-dependent.

In a similar study, Smythe et al. (2008) found that when these two languages were contrasted, measures of phonological decoding were less reliable predictors of word-level literacy weaknesses amongst Hungarian children than amongst English children. This same low-level of prediction was found when testing children learning to read Chinese characters. However, despite these findings, those with good and poor literacy skills from Hungarian- and Chinese-language backgrounds did show relationships between phonological awareness and literacy levels (see Smythe et al., 2008). Hence, it is not that children learning to read and write in Chinese do not show this relationship between phonological processing and literacy, rather the relationship varies across orthographies.

Such cross-language research is not only useful for theory development, but can inform the practical purpose of identifying, or predicting, those struggling with literacy acquisition. This should be useful in different first language contexts, but may also inform assessment practices targeted at those who are required to learn literacy in a second language. Indeed, empirical studies of the incidence and manifestation of literacy-related learning difficulties in children learning to read and write in two languages is a growing area of research (e.g.Everatt et al., 2010; Geva & Siegel, 2000; Peer & Reid, 2000; Veii & Everatt, 2005). One reason for this growing body of research is that most current tools used to identify children with literacy learning problems have been developed for the English-speaking child. There is a vast amount of literature on normal reading development and reading disorders. Most of these works consider phonological awareness as the best predictor of reading development (for a review, see Goswami, 2000) and as the core deficit underlying the reading problems of dyslexics, who show difficulties in single word decoding (e.g., Bradley & Bryant, 1978). However, reading is more than converting orthographic forms into phonological forms and phonological awareness alone cannot explain all the variance in reading performance of children at different reading stages (Frith et al., 1995). Other cognitive constructs have also been investigated to explore important factors contributing to reading success and to account for various deficits in dyslexia. These skills include visual and orthographic skills, naming speed and morphological awareness.

Consistent with this range of processes, underlying factors related to literacy learning difficulties may vary between orthographies, as well as aspects of the language or culture within which an individual is immersed, which may make an assessment tool inappropriate within some contexts (Everatt et al., 2000; Goswami, 2000; Katz & Frost, 1992; Leong & Joshi, 1997; Smythe et al, 2004). For example, in Chinese (the language of focus in the present work), the basic writing unit is a character made of strokes, which are packed into a square. The visual complexity of Chinese characters has aroused considerable interest in the contribution of visual skills to Chinese reading development (Huang & Hanley, 1995). While some studies on Chinese support a universal role of phonological awareness (Hu & Catts, 1998), others have found that orthographic skill, naming speed or morphological awareness were also crucial for reading in Chinese (McBride-Chang & Ho, 2000) and could discriminate Chinese poor readers from the good readers (Shu et al., 2006). Indeed, the study of Holm and Dodd (1996) provided counter evidence for the fundamental role of phonemic awareness in literacy acquisition. In this study, highly literate Hong Kong students who had acquired literacy skills via Chinese character reading lacked phonemic awareness. These individuals performed poorly in English phonological segmentation tasks, even following years of alphabetic reading instruction. Hence, these researchers proposed the view that phonological awareness was not a universal prerequisite of reading acquisition, but rather a consequence of a specific type of reading development.

Morphological Awareness in Alphabetic Language

Morphological awareness refers to the ability to reflect upon and manipulate morphemes, and employ word formation rules in one's language (Carlisle, 1995). The smallest unit that carries meaning is a morpheme. It can be measured in a number of ways. For example, an implicit awareness of morphology task may ask children to select an appropriate word that best fits in a sentence, such as 'she is a writer/write', whereas an explicit task might require children to identify the base of a multi-morphemic words as in 'what is the base of successfully?' (see Deacon et al., 2007). Amongst English children speaking, awareness of the morphological structure of words has been found to correlate with both vocabulary knowledge (Carlisle & Fleming, 2003; Nagy et al., 2003; Singson et al., 2000) and reading comprehension (Tyler & Nagy, 1990); though the contribution of morphological knowledge might derive from phonological abilities (Fowler & Liberman, 1995). Increasingly, however, such research suggests that morphological knowledge makes an independent contribution to reading over that of phonological skill, with the relative importance of morphological processing increasing with schooling (Deacon & Kirby, 2004). Singson et al. (2000) reported that, in third grade, only phonological awareness made a unique contribution to reading ability. However, by fourth through sixth grade, the contribution of morphological awareness relative to that of phonological awareness increased. Additionally, Mann and Singson (2003) reported that, by fifth grade, the best predictor of decoding morphological complex words was morphological awareness, not phonological awareness.

Consistent with these studies, Deacon and Kirby (2004) reported that morphological awareness was a significant predictor of reading performance in 4th and 5th graders beyond the influence of phonological awareness, but not for students in grade 3. McBride-Chang et al. (2005) administered test speeded naming, phonological awareness and morphological awareness to kindergartners and second graders. They found morphological awareness predicted an independent 10% of variance in vocabulary knowledge. Nagy et al. (2006) investigated the distinct contribution of morphological awareness, phonological memory, and phonological decoding to reading comprehension, reading vocabulary, spelling and decoding accuracy and rate. Participants were students from grade 4 to grade 9 in an American suburban school. They found that, after controlling the shared variance with other predictive factors, morphological awareness remained a significant predictor of all reading measures.

Studies of children with reading difficulties also support the hypothesis of an independent important role of morphological awareness in reading. Nagy et al (2003) found that for second-grade at-risk readers, morphological awareness made a significant unique contribution to reading comprehension even when variability in orthographic and phonological abilities, and oral vocabulary had been controlled. In contrast, fourth-grade students' data did not show a significant unique contribution of morphological awareness to any of the outcome measures, even though levels of morphological awareness were correlated with word reading. Studies of morphological instruction on reading improvement also support a relationship between morphological awareness and literacy levels (Nunes, Bryant & Bindman, 2006).

Rapid automatized naming and Alphabetic Reading

Rapid automatized naming (RAN) has often been used as a measure of the ability to retrieve phonological codes from permanent memory. Wolf (1991) found that the speed at which children retrieve phonological codes associated with letters, word segments, and whole words influences the success with which they can use phonological information in decoding. Other studies in reading have demonstrated that naming performance, especially serial naming, is strongly correlated with reading performance (Stanovich, 1981; Wagner, Torgesen, Laughon, Simmons & Rashotte, 1993). Similarly, a longitudinal work by Bowers (1995) demonstrated that naming speed in Grade 2 made a unique contribution to reading comprehension in Grade 4 whereas phonemic awareness in Grade 2 accounted for a unique variance in word reading measures two years later. It has been argued that naming speed is a longitudinal predictor of reading comprehension, and that children with slow naming speed at an early time are more likely to have reading problems compared with children with normal naming speed. Although such rapid naming skills may be simply a feature of skilled reading or another aspect of phonological processing (see Smythe et al., 2008; Wagner & Torgesen, 1987), there are those that argue for rapid naming to be independent of phonological skills and a unique predictor of reading levels (Wolf, O’Rourke, Gidney, Lovett, Cirino & Morris, 2002). Indeed, Ho et al., (2002) have suggested that weaknesses in rapid naming tasks should be considered as indicative of a dominant cognitive deficit among Chinese speakers with dyslexia.

Additionally, some research suggests that rapid automatized naming may be a larger predictor of reading when processing more transparent than more opaque orthographies (e.g., Georgiou, et al., 2008; Wolf et al., 2002), which argues for variations in the influence of RAN across different orthographies. Consistent with the influence of rapid naming in transparent orthography, Furnes and Samuelsson (2010) found rapid automatized naming to be a stable predictor of reading speed across school years when the child was learning a transparent orthography. However, the effects of rapid automatized naming across orthographies have not been as consistent as some other areas of processing. For example, Patel, Snowling & de Jong (2004) found RAN to not a non-significant predictor of reading accuracy and reading speed in Dutch and in English despite the differences in transparency across these languages. In contrast, Moll et al. (2014) found that measures of RAN were a significant predictor of reading in both more and less transparent orthographies. Hence, the specific role of rapid naming as a predictor of reading levels has yet to be determined clearly, including in Chinese, particularly given that relationships with orthographic transparency have been found to be highly variable across studies.

Chinese context: language, orthography and learning

As mentioned above, orthographic transparency could influence the importance of phonological awareness in reading success and developmental patterns. However, it is possible that in a non-alphabetic language, such as Chinese, the prediction power of phonological awareness and various cognitive constructs might be different from those in alphabetic languages. There are two written representations of Chinese that children are expected to acquire. The more alphabetic-form of the pin-yin script and the Chinese character orthography, which uses a large number of symbols to represent concepts and, in many cases, to provide a guide to pronunciation. The former pin-yin script is more transparent than English, though there are inconsistencies that make it less transparent than Hungarian, for example. Hence, it may be more difficult to identify underlying decoding-related phonological weaknesses in pin-yin readers as it is in learning of other relatively more transparent scripts. Similarly, measures of rate of reading may be better indicators of variance in reading levels than measures of reading accuracy often used in English tests (see Wimmer, 1993), with measures of phonological fluency (such as rapid naming tasks) potentially being better predictors of these reading levels than measures of accuracy in phonological tasks (see Landerl et al, 1997). Additionally, the Chinese-character orthography has a very different relationship between individual written symbols and language sounds than that found in scripts which follow the alphabetic principle of basic sounds being represented by letter symbols. Again, it might be expected that relationships between different measures of phonological decoding skills and word level literacy will vary due to this difference in the way language is represented by the script. Thus, although phonological processing measures based on those used in English have been found to distinguish variability in reading levels in Chinese-language children, they are often modified for the language context in which they are used: e.g., fluency in addition to accuracy measures. Furthermore, these phonological processing measures may have to be supplemented by additional measures related to the specific features of Chinese: for example, Chinese characters were designed to represent morphemes, hence morphological awareness may supplement phonological awareness when reading Chinese characters (see a similar argument in Mahfoudhi et al, 2009). Hence, the identification of the specific relationship between Chinese literacy acquisition and phonological processing skills requires further research.

Chinese language and writing system

Chinese is the language spoken by more people in the world than any other language. There are two terms (Hanyu and Zhongwen) that are used to refer to the Chinese language in China. The term Hanyu, which is widely used in China to refer to the Chinese language, literally means “the language of the Han”. Han was the second imperial dynasty of China and has come to be used to refer to ethnic Chinese. However, the term Zhongwen, meaning the “language of the Chinese people” is widely adopted in most Chinese language textbooks. As one of the seven major dialect groups in China, Mandarin is spoken by nearly 1000 million Chinese people and is understood by 95% of the population. Mandarin is not a language, but is a vocal representation of Chinese. The standard Mandarin, called Putonghua, is based on the Beijing dialect. The term Putonghua, which means “common speech”, is used in mainland china as an administrative and official medium. More importantly, standard Mandarin/ Putonghua has been promoted to the language of instruction in primary and secondary schools in mainland China. Standard Mandarin is the focus of the present paper.

The Chinese writing system is neither alphabetic nor phonetic, its features being more consistent with a logographic script in the form of characters and relationships with meaning and pronunciation. Most dialects in China are not mutually intelligible, but the written form is the same across all of the Chinese dialects. This unified writing system has helped people in China, who cannot communicate through speech, communicate through the written language. Due to the limited number of possible sound combinations (i.e., there are 400 syllables) and the abundance of homophones in Chinese, ten words may be pronounced exactly the same, but written differently.

The modern Chinese writing system uses simplified characters that are usually considered to be logographic (Henderson, 1982); though DeFrancis (1984) argued that Chinese might be more appropriately labelled as a "morphosyllabic" rather than a "logographic" writing system. This is because the basic unit of writing is a character that typically represents one morpheme and corresponds to one syllable in speech. Each Chinese character is made up of strokes, which are the smallest structural unit of a character. A stroke has no meaning nor pronunciation. There are 24 distinct strokes and the visual complexity of a character is measured by the number of strokes contained in that character (Li&Chen, 1997). For example, the character 一 （one） contains one stroke, 十 (ten) contains two strokes, 百（hundred） contains six strokes and 潮(tide) contains fifteen strokes. A change in stroke would change the character into another one, like 未（have not yet ）and 末 (end) contain exactly the same strokes but in different combinations, which results in two different characters. Characters are also referred to as square characters, because each one is shaped like a square. Irrespective of the complexity of strokes and structures, each character occupies the same amount of space as the next one.

Chinese characters may be divided into two categories: simple characters and compound characters. Only a small number of characters are simple ones that cannot be divided into components, like 文（script）. More than 80% of characters are compound characters which are composed of two parts, a left part and a right part or a top part and a bottom part. In either formation, one part, or radical, usually appears on the left or the top, and is a category label that provides clues to the semantic classification of the character. For example, all of the following characters share the "wood" radical, because all of them have to do with wood:森（forest），根(root)，树(tree).

The other component of the character, usually appearing on the right or the bottom, provides phonetic clues to the pronunciation of the character. For instance, in the character 燃（ignite）, the radical 火 is the semantic radical which gives a cue to the meaning of the character (something relevant with fire), and 然 is the phonetic radical and an independent character by itself, which has the same pronunciation as the whole character. Although both semantic information and phonological information can be indicated by the radicals within compound characters, this information is often unreliable, and even when it is reliable, understanding it requires parsing that is different from the way that English words are parsed. The phonetic clue is only a rough one and becomes useful only when you already know a substantial number of characters to make a prediction.

The basic phonetic unit in Chinese is a syllable. One syllable represents phonetically the pronunciation of one Chinese character. The segmental structure of a syllable in Chinese begins with an initial, followed by a final with a tone. Initials are initial consonants, while finals are all possible combinations of a medial (semivowel) and a coda (final vowel or consonant). In the Chinese language, initials (声母) and finals (韵母) (not consonants and vowels) are the fundamental elements of the Chinese phonetic system. Chinese is not a phonetic language in terms of its orthographic representation, and the characters do not bear any resemblance to actual pronunciation. Therefore, a system of transcribing Chinese phonetics was needed to assist people learning to read Chinese characters. In mainland China, the pinyin system (which means putting sounds together) was developed in 1958 with the purpose of introducing standard pronunciation of mandarin to school children. This more alphabetic-based system, therefore, supports initial development of reading by making explicit the link between the pinyin written symbols and the language sounds in mandarin Chinese.

Chinese characters are conventionally classified into six types, based on their origins (Taylor, 1981). These six types are pictographs, simple ideographs, compound ideographs, semantic-phonetic compounds, analogous characters, and loans. The first four categories are related to the formation of characters, and the last two are applications of existing characters.

Pictographs have been seen as the earliest form of Chinese writing. They were most likely based on even earlier pictorial representations of objects, though with abstraction that naturally occurs in writing over time. Examples of this type include: 日 (sun), 月 (moon), 耳 (ear), 龙 (dragon) and 山 (mountain). Pictograms make up only a small portion of Chinese characters. It has been estimated that about 4% of characters fall into this category (DeFrancis, 1984).

Simple ideographs indicate ideas that usually are abstract and cannot be easily depicted by pictures. Examples include symbols and concepts such as 上 (up) and 下 (down). In these examples, the horizontal line represents the earth, as an indication of relative position. Relatively few characters (about 1%) fit into this category (DeFrancis, 1984).

Compound ideographs are sometimes referred to (or translated literally) as *logical aggregates* or *associative compound.* These characters symbolically combine pictograms or ideograms to create a third character. For instance, combining 日 (sun) and 月 (moon), the two natural sources of light, makes 明 (bright). Other examples include the characters 林 (forest), which is composed of two instances of the pictogram 木 (tree), and 炎 (hot), which is composed of two instances of the pictograms 火 (*fire*). It is estimated that 13% of characters fall into this category (DeFrancis, 1984).

Phono-semantic compounds are by far the most numerous characters, comprising about 82% of modern Chinese characters, and this percentage has been increasing over the centuries (DeFrancis, 1984). Semantic-phonetic compounds are composed of two parts: one component (radical) provides information about a character's semantic category, and the other component (phonetic) roughly indicates its pronunciation. For example, the character 铜 [tong2] (copper) consists of two parts, a radical based on 金 (metal) and a phonetic part 同 [tong2] (the same). The radical and phonetic parts of a Chinese character are not always reliable indicators either of meaning or of pronunciation. Only 26.3% of phonetic radicals have a pronunciation identical with that of the whole character (Fan et al., 1984) and the semantic radical provides only a general indication of semantic category. Therefore, in many cases, the compound still needs to be learnt as an individual entity.

Transformed cognates are characters that have been patterned after an old character in that they are analogous in meaning to the older character but do not necessarily share the same sound as the older character. For example, the characters 考 [kao3] (to verify) and 老 [lao3] (old) were once the same word, meaning "elderly person", but became lexicalized into two separate words. Characters of this category are rare, so in modern systems they are often omitted or included as part of another category of character.

Rebus are borrowings or phonetic loan characters. This category covers cases where an existing character is used to represent an unrelated word with similar or identical pronunciation. For instance, the character 令 [ling4] (command) was used to refer to 长 [zhang3] (chief) in the old days. Today, this kind of character has its own meaning, like the character 长 [zhang3] meaning “grow”.

These examples are used to indicate the special features of the Chinese character system. As can be seen from these examples, although there is a lack of the grapheme-phoneme correspondence in this writing system, a single Chinese character does map onto a pronunciation that involves one syllable – and such a syllable can be considered as analyzable into two sub-syllabic units, the onset and the rime. Hence, there is a relationship between the Chinese character system and phonology, but this relationship is not the same as found in an alphabet-based orthography, such as in English.

Chinese Phonology

One of the major features of non-alphabetic Chinese writing is the potentially arbitrary relationship between sound and print. Each character is a syllable and none of the constituents (e.g., strokes) provide phonological structures (e.g., phonemes). The sound of a Chinese character is not directly determined by combining its orthographic constituents, which is quite different from the representation of sound by alphabetic letters in English. Due to this lack of phonetic cueing provided by Chinese characters, the Pinyin system was developed to be used to represent the pronunciation of Chinese. Pinyin, which literally means "spell the sound" in Chinese, is a system where each symbol represents a phonological element of Chinese syllables. Chinese syllables are usually presented in three phonological elements: initial sound, final sound, and tone. Pinyin consists of 47 symbols: 23 initial sounds and 24 final sounds. These 47 symbols are similar to the onset and rime elements. Among the 24 final sounds, three (i, u, ü) are also used to refer to medial sounds and can be placed in the middle of the syllables when combined with an initial sound and another final sound. For example, an initial sound (ch), a medial sound (u), and a final sound (an) will form the syllable (chuan).

The 23 initials (onset) in Pinyin are as follows:

b p m f d t n l g k h j q x zh ch sh r z c s y w

Of the 24 finals in Pinyin, there are 6 simple finals which are single vowels:

a, o, e, i, u, ü

A further 14 compound digraph finals are:

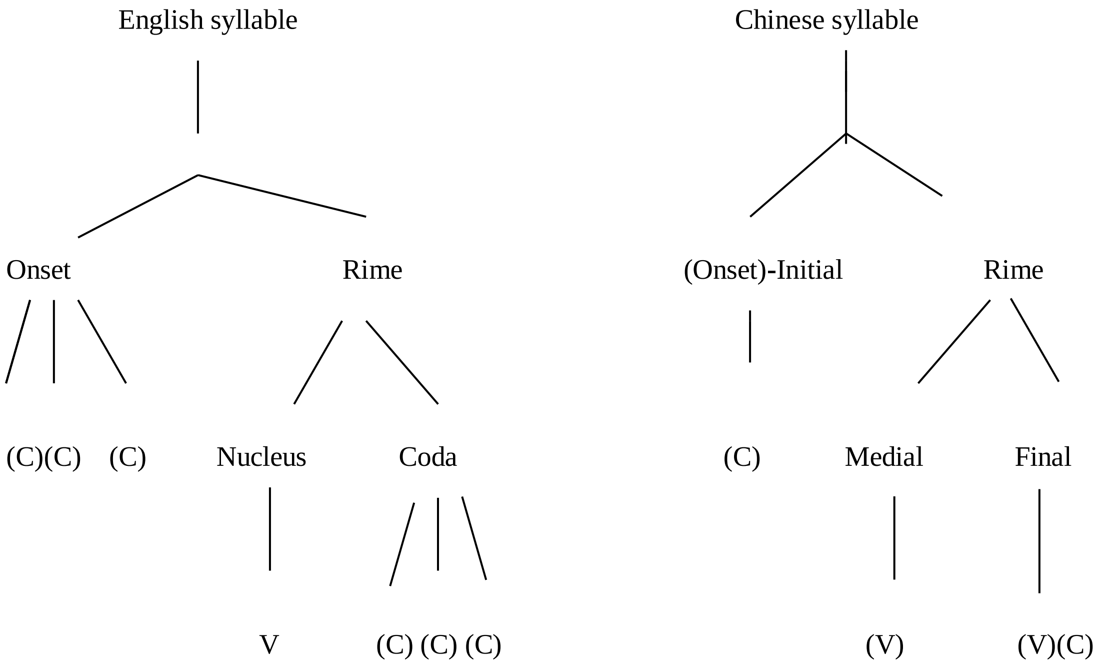
ai ao an ei en er ie iu in ou ui un üe ün

And there are 4 compound trigraph finals:

ang eng ing ong

Chinese has a simple syllable structure, mostly (C)V(C). The structure of a syllable in Chinese consists of initial , final ,and tone or initial , medial , final and tone (see figure 1). The final may be further broken down into a vowel, and an ending. For instance, in/tian1/,the final/an/ can be segmented into a vowel/a/ and a nasal consonant /n/.Consonant clusters do not generally occur in either an initial or final, which may not facilitate the emergence of phonemic awareness in Chinese. Based on this, there are around 400 syllables which, with tonal variation, leads to about 1200 syllable-pronunciations; about an eighth as many as English (Li & Shi, 1986). Of particular note is that initials are optional and not necessary to form Chinese syllables and two syllables may rhyme with each other even if they do not have exactly the same rime, as long as the "finals" are the same, as in 道 [dao4] (way) and 钓[diao4] (go fishing).

Figure 1. (a) English syllable structure. (b) Chinese syllable structure.



A tone is an important phonetic feature of Chinese. Therefore, Chinese is considered as a tonal language. In Chinese Mandarin, there are 4 tones with an exceptional light tone. The four tones are represented respectively in Pinyin by the following tone marks: /一/ (the first tone), / / / (the second tone), /∨/ (the third tone) and / \ / (the fourth tone). The tone marks are put on top of the nucleus of each syllable. There is no tone mark on the light tone. The first tone is the flat or high level tone, the second tone is the rising or high rising tone, the third tone is the falling-rising or low tone, and the fourth is the falling or high falling tone while the light tone is actually a neutral tone. These tones are analogous to the musical notes, do, re, mi, fa, and so (Chao, 1968). A very common example used to illustrate the tones in Chinese is seen as follows: 妈 [mal] (mother), 麻 [ma2] (hemp), 马 [ma3] (horse), 骂 [ma4] (to scold), and 吗 [ma] (question marker). As noted above, Mandarin has only 400 different syllables that usually consist of an onset and a rime, but with the variation of tones, the number of tone-syllables increases to 1,200 (Li & Shi, 1986). Therefore, characters with an identical phonetic structure can be differentiated by tone; otherwise, approximately every ten characters would be homophonous. Tones also function as a supra-segmental phonological feature of Chinese syllables, which implies that tones are attached to the entire syllable as a whole. Accordingly, sensitivity to tones is crucial for understanding Chinese. It is noteworthy that there are no visual cues provided in Chinese characters that specify tones. However, in the Pinyin script tones and sub-syllable phonological information are represented.

Pinyin was invented to compensate for the lack of phonological information in Chinese characters, as well as to help children make associations between sound and print in a more efficient and convenient manner. Children can use Pinyin as aids to help them decode unknown characters. In mainland China (as opposed to Hong Kong), elementary pupils receive training in the Pinyin system before they learn to read Chinese characters. Children start to learn the Pinyin script as soon as they start receiving formal instruction in grade one. It takes about 12 weeks for first-grade children to learn the Pinyin system. Later on, these phonetic symbols will appear alongside Chinese characters in textbooks until the third grade in mainland China. When children reach higher grades (grade 4 & 5), the phonetic symbols are only provided when new characters are introduced. For example, Grade 1 pupils after training on the pinyin system, would be taught to name the Chinese character “河” (he2) as a blending of the initial (onset) /h/ and the final (rime) /e2/ (note that the number following the syllable indicates the level of a tone).

Chinese Morphology

In Chinese, each morpheme is typically represented by a syllable, whereas in languages like English, a morpheme can consist of one or more syllables: such as ‘nice’, which comprises one syllable and one morpheme, versus ‘monosyllabic’ which has five syllables and two morphemes (mono and syllabic). In English, a morpheme can even be realized by a consonant, such as ‘s’ in ‘cats’. Morphemes in English are often bound, meaning that individual morphemes cannot stand alone but have to be strung together to form a word. In Chinese, most morphemes are free, rather than bound, and can stand alone as independent words. Much of Chinese vocabulary consists of two-character words. For example, the word for "Pinyin" is a two-character, bisyllabic, bimorphemic word composed of the characters 拼 [pin] (which basically means to put together) and 音 [yin] (which means sound). In most cases, a connection between the meaning of an individual character and the meaning of the two-character words can be inferred.

Hoosain (1991) notes that a "Chinese character provides a dovetailed unit, simultaneously representing the smallest unit of meaning [morpheme] as well as the smallest salient unit of sound at the psychological level" (p. 13). Researchers have proposed that morphological awareness may be particularly important for learning to read Chinese because of its unique morphological features. In Chinese, there are strong relationships between graphemes and morphemes, rather than between orthography and phonology; and, hence, learning Chinese might be said to involve the appreciation of grapheme-morpheme correspondence rules. Therefore, learning to read Chinese may involve greater, or earlier acquired, connections between orthography and meaning than some other languages that use an alphabetic orthography. In addition, modern standard Chinese consists of 4600 commonly used characters, but there are roughly 420 different syllables (disregarding tones). Thus for every syllable there are, on average, about ten characters that share the same syllable. This would seem to indicate that, during reading, greater reliance on meaning would be necessary as reliance on phonological cues might lead to confusions among the ten other syllables with the same pronunciation.

Moreover, Chinese is an analytic and relatively semantically transparent language. Character compounding (i.e., combining two or more characters) is the most common way of forming words, and typically involves the meaning of each constituent morpheme contributing directly to the meaning of the compound. For instance, in Chinese, several compound words would contain the morpheme 学 /xue2/ (study), such as 学校 /xue2xiao4/ (school), 学生 /xue2sheng1/ (student), 学期 /xue2qi1/ (semester), 学费 /xue2fei4/ (tuition), 学时 /xue2shi2/ (class hour). The appreciation of morphology, therefore, can aid children in deciphering and acquiring the meanings of the polymorphemic vocabularies.

As stated above, a morpheme is the smallest meaningful linguistic unit. Morphemes can be classified into free vs. bound, derivational vs. inflectional and lexical vs. grammatical morphemes. Free morphemes in Chinese like those in English can stand alone or appear with other lexemes. For example, 水 (water) and 风 (wind) are free morphemes and they could be combined with other lexemes to form new words, such as 河水 (river water) and 风扇 (fan). Bound morphemes in Chinese cannot stand alone, as in 缥缈 where the two elements go together to form the meaning "misty". Derivational morphemes produce a new word by being attached to root morphemes or stems, and are composes mainly of prefixes and suffixes (Packard, 2000). In Chinese, the morpheme of 同 (the same) in 同意 (to agree) and 同情 (to sympathize with) changes the meaning of the words, and the morpheme of 生 (to grow) in 学生 (student), 男生 (male student) and 女生 (female student) changes the verb into nouns. In contrast, inflectional morphemes, such as grammatical markers, like "-ed" and "-ing" in English, indicate syntactic relations between words. For instance, the morpheme 们 in 你们 (you) and 他们 (they) is a plural morpheme. Finally, lexical morphemes form the majority in the language. These are content words, or open class morphemes, like the morpheme 电 (electricity), which can be combined with another morpheme to form a different word, such as 电话 (telephone) and 电脑 (computer). Grammatical morphemes are functional words, or closed class morphemes, like 吧 in

Chinese. Therefore, the three types of morphologically complex words in English (i.e., inflections, compounds, and derivatives) are similarly found in Chinese (Packard, 2000). However, the two languages diverge in terms of the prominence of each type of morphological structure. In Chinese, compounding two or more characters is the most common way of forming words. There are about 73.6% disyllabic compounds made up of two characters in a large Chinese text corpus (Institute of Language Teaching and Research (in China), 1986). In contrast, there are far fewer inflectional and derivational affixes.

The following paragraph summarized the key features of Chinese discussed above. The basic unit of writing Chinese is a character that typically represents one morpheme and corresponds to one syllable in speech. Although there is a lack of the grapheme-phoneme correspondence in this writing system, a single Chinese character does map onto a pronunciation that involves one syllable. However, the relative number of characters versus the number of syllables means that there are a large number of homophones with identical pronunciation but different meanings that the learner of Chinese will potentially encounter. Therefore, a reliance purely on phonological cues may lead to confusions among homophones, particularly without a constraining context. In contrast, a reliance on the meaning (or morphological composition) should give more accurate information about orthographic representation. Hence, there are recognizable relationships between the Chinese character system and the language's phonology and morphology, but these relationships are not the same as found in an alphabetic orthography.

Reading acquisition in Chinese – Research and practice

Literacy instructional practices in Mainland China , Hong Kong and Taiwan

In mainland Chinese (which can be contrasted with Hong Kong and Taiwan), Hanyu Pinyin is been used to compensate for the lack of phonological information in Chinese characters, as well as to help children to make associations between sound and print in a more efficient and convenient manner. Children can use Pinyin as aids to help them decode unknown characters. In mainland China, elementary pupils would receive training in the Pinyin system before they learn to read Chinese characters. First grade children are expected to learn the Pinyin system; although the phonetic symbols will appear alongside Chinese characters in textbooks until the third grade, and when new characters are introduced in higher grades (grade 4 & 5). Pinyin uses 26 Roman letters, either singly or in combination, and, particularly in primary school textbooks, is usually placed above a Chinese character. It is commonly taught by beginning with the names of the 23 consonantal initials, followed by the 24 finals and the 3 medial sounds. Children are given extensive training in combining these initials, medials, and finals to form meaningful syllables. For example, they learn how to combine the initial /zh/ the medial/u/ and the final /ang/ to form the syllable /zhuang/ in different tones. When learning nasal finals such as /ang/, they are told that /ang/ is a unitary phoneme, which cannot be further segmented into /a/and /ng/. Thus, identifying individual phoneme is not the basis of learning Pinyin; hence, the status of phonemes in Pinyin is somewhat different from that in alphabetic languages. Furthermore, research evidence has shown that Pinyin learning will affect children's sensitivity to the sound structure of words in the Chinese language (Huang & Hanley, 1997; Mcbride-Chang, 2004).

However, a great deal of research on Chinese reading development reported in the English language literature has come from Hong Kong where children are taught differently. Children in Hong Kong are generally taught to read Chinese characters via a look-and-say whole-word approach, based on rote memory without any phonetic tools. They are usually taught character-to-pronunciation mappings without the aid of a more alphabetic-based script, such as Pinyin. They learn new characters by practicing repeatedly the sound and writing. Therefore, it is possible that different instructional methods between mainland China and Hong Kong (as well as differences in scripts experienced) result in different cognitive processing skills that might be vital for children to achieve reading success at the early stage of Chinese reading development. Hence, research findings derived from studies in Hong Kong may not be representative of mainland China, and more research on children’s reading development in the context of teaching in mainland China would be useful to confirm or refine current perspectives on Chinese reading acquisition.

In Taiwan, children learn Zhu-Yin-Fu-Hao during the first 10 weeks of the first grade before they begin to learn Chinese characters. Zhu-Yin-Fu-Hao is a phonetic system devised in 1912, which represents the pronunciation of Chinese characters in Taiwan. Zhu-Yin-Fu-Hao is derived from a set of simple ancient Chinese scripts, and in reality is not a real writing system at all. This system consists of 37 phonetic symbols, where 21 symbols representing various initials, 3 representing medials, and 13 representing various finals. The function of Zhu-Yin-Fu-Hao, similar to that of Pinyin, is to help children to form the association of speech sounds and Chinese characters. The way Zhu-Yin-Fu-Hao is taught is similar to that of Pinyin. In the elementary textbooks, Zhu-Yin-Fu-Hao is printed on the right of all new characters to indicate the standard pronunciation. In Taiwan, children are taught Zhu-Yin-Fu-Hao in the first ten weeks of grade one, and continue to use the system throughout the rest of the primary school years. The difference between Zhu-Yin-Fu-Hao and Pinyin is that Zhu-Yin-Fu-Hao transcribes Chinese syllables by unique symbols at the onset and rime level while Pinyin adopts Roman alphabets and transcribes at the phoneme level (Cheung & Ng, 2003). Otherwise, the function of these two systems is identical. Some researchers acknowledged that the differences in writing system and formal teaching of Chinese led to the differing cognitive predictors of Chinese reading among studies in different Chinese communities. For example, in Hu (2013) the concurrent and longitudinal contributions of phonological awareness and morphological awareness to Chinese reading were examined among the third grade students of Chinese in Taiwan. The results revealed that phonological awareness made a significant unique contribution to Chinese character reading concurrently at grade 3 and subsequently at grade 5, whereas morphological awareness contributed no additional unique variance to character reading at grade 3 beyond phonological awareness, but became significant at grade 5 over and above phonological awareness. The findings were not in line with the results of studies from Hong Kong that suggest morphological awareness is predictive of early Chinese reading, whereas phonological awareness is not (Yeung, 2014). It seems that studies conducted in different Chinese communities might demonstrate differential predictive patterns in identifying the relationships between cognitive skills and Chinese reading.

Phonological processing in Chinese reading

The effect of phonological awareness of spoken words (i.e. applying an auxiliary phonetic system) in reading Chinese has been in controversial. Everatt et al. (2004) argued that the variation in transparency of the orthography has been found to affect the relationship between literacy acquisition and phonological awareness. Similarly, Smythe et al. (2008) found that when two languages were contrasted, measures of phonological decoding were less reliable predictors of word-level literacy weaknesses amongst children learning a more transparent than a less transparent orthography. This same low-level prediction was found by these researchers when testing children learning to read Chinese characters. However, despite these findings, those with good and poor literacy skills from Hungarian and Chinese-language backgrounds do show relationships between phonological awareness and literacy levels (see Smythe et al., 2008). Hence, it is not that children learning to read and write in Chinese do not show this relationship between phonological processing and literacy, rather the relationship may vary across orthographies.

Other research has also demonstrated that phonological skills predict Chinese reading level among beginning readers. Huang and Hanley (1997) conducted a one-year longitudinal study with 40 first grade students in Taiwan. They investigated whether phonological awareness skills before formal instruction predicted reading a year later. Three testing sessions took place just before the children had learned the alphabetic system Zhu-Yin-Fu-Hao, immediately after the children had learned Zhu-Yin-Fu-Hao, and finally, at the end of the first year of schooling. Huang and Hanley found that phonological awareness tasks correlated with character recognition at the three testing times and that early phonology predicted character recognition at the end of grade 1 after statistically controlling for the effect of IQ.

Furthermore, Hu and Catts (1998) reported that performance on phonological awareness task, but not on visual task, was related to Chinese character reading ability among 50 first graders from Taiwan. Hu and Catt (1998) studied the reading performance of 50 first year graders in Taiwan with three measures of phonological awareness, phonological memory, phonological retrieval and visual memory of random visual shapes. Results showed that children’s performance on the visual memory task was not related to their performance on either of the reading measures. In contrast, performance on the phonological awareness tasks was highly related to performance on both reading tasks.

Another study by Newman et al. (2011) examined the role of phonological awareness in reading in Chinese by exploring the role of phoneme-level awareness in Mandarin Chinese. A sample of 71 four to eight year old monolingual Mandarin-speaking children from mainland China completed a phonological elision task and a measure of single-character reading. In this study, 4- and 5-year-old preschoolers were unable to complete phoneme-level deletions, whereas 6- to 8-year-old first graders were able to complete initial, final, and medial phoneme-level deletions. In older groups, performance on phoneme deletions was significantly related to reading ability even after controlling for syllable- and onset/rime-level awareness, vocabulary, and Pinyin knowledge.

However, there is also evidence that argues phonological awareness is not related to Chinese reading acquisition. Huang and Hanley (1995) reported phonological skills were correlated with reading abilities in British children, but not Hong Kong and Taiwanese children. They also found that Hong Kong children and Taiwanese children exhibited a correlation between visual skills and reading abilities. They concluded that learning to read Chinese seems to depend much less on phonological awareness skills than learning to read English.

In a study by McBride-Chang, Bialystok, Chong and Li (2004) Chinese kindergarten and grade 1 children who had learned Pinyin outperformed Hong Kong children with no Pinyin instruction on syllable deletion and onset deletion tasks. Although the Hong Kong children did poorer on the phonological awareness tasks, they performed significantly better on a character recognition task. Based on these findings, McBride-Chang et al. suggested that Pinyin training may promote the development of phonological awareness and the incorporation of the phonetic system in reading instruction, thereby improving children's performance in manipulating Chinese syllable segments. However, improvements in Chinese phonological awareness skills do not necessarily lead to better Chinese reading, which questions the role of phonological awareness in Chinese reading.

In contrast to the last conclusion, studies of Chinese reading disabled children have identified a potential influence of phonological deficits. For example, So and Siegel (1997) compared 144 normal readers and 52 poor readers in Hong Kong, from Grade 1 to Grade 4, on measures of phonological, semantic, and syntactic skills, as well as working memory. Poor readers were found to show significant delays in the development of linguistic and working memory skills. As expected, poor readers at each grade performed significantly worse than normal readers on all measures, especially working memory skills. There were significant differences between each grade for poor readers on all language tasks, except for the working memory task. The mean scores for poor readers in Grade 3 or 4 were significantly higher than Grades 1 or 2. Poor readers showed a significant delay in the acquisition of these skills with the most severe problems at the phonological and semantic levels. Similarly, Shu et al. (2006) found that phonemic awareness was particularly important in explaining reading impairment among fifth- and sixth-grade Beijing students and could distinguish disabled from nondisabled readers in older children for learning new characters. This evidence suggests that Chinese children with reading disabilities have deficits in processing phonological information similar to readers of alphabetic languages. Phonological processing ability may be considered as a potential cause of reading disabilities in Chinese because of its strong correlation with reading. However, reading Chinese may require different processes than those required for reading alphabetic orthography. The knowledge of an alphabetic script (pinyin script) seems to influence phonological awareness; hence the role of phonological processing skills in learning to read Chinese may vary with Pinyin skills. Given the equivocal evidence, and the potential differences across educational systems, the specific relationship between Chinese literacy acquisition and phonological processing skills is still to be determined and requires further research.

Morphological processing in Chinese reading

There is a trend for Chinese researchers (e.g., Tan & Perfetti, 1997; Ho & Bryant, 1997; Hu & Catts, 1998; Huang & Hanley, 1995, 1997; Read, Zhang, Nie, & Ding, 1986) to follow models based on English-language work and focus on the roles of phonological processing and phonological awareness in Chinese reading more than on other areas of processing, such as morphological awareness. However, empirical studies support a relation between morphological awareness and reading development in both English and Chinese. Studies in native English speakers have consistently shown that mature mental lexicons are morphologically organized (Tyler & Nagy, 1990) suggesting that experienced readers decompose these words into their constituent morphemes prior to processing and storage (Marslen-Wilson, Tyler, Waksler & Older, 1994). In research involving speakers of Chinese, similar results in support of a morpheme-based mental lexicon have also been obtained. For example, Zhou et al (1999) argued that meaning is directly activated through orthography in Chinese reading. Thus, across languages, morphological awareness may facilitate efficient word storage, retrieval and processing, all of which support advancements in reading abilities.

Most of the studies on the role of morphological awareness in Chinese reading development have focused on children's understanding of meaning s and structures of compound words. (Ku & Anderson, 2003; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003). McBride-Chang et al. (2003) tested morpheme awareness in kindergarteners, second and third graders in Hong Kong using morphological identification and morphological construction tasks. Their results showed that both tasks predicted unique variance in Chinese character recognition and morpheme awareness improved with age.

Additionally, Ku and Anderson (2003) found that Chinese (Taiwan) second-, fourth-, and sixth-grade students were similar to their English-speaking counterparts in that their morphological awareness significantly predicted reading comprehension, even when vocabulary knowledge was statistically controlled. These researchers also reported that middle and upper elementary school children become progressively more proficient at interpreting low-frequency compounds composed of high-frequency base words, and at distinguishing between well- and ill-formed compounds.

In a large scale study involving children from Beijing, Hong Kong, Korea and America, McBride-Chang and colleagues (2005) included a number of reading-related factors, such as phonological awareness, vocabulary, and speeded naming, besides morphological awareness. For all participants, the phonological awareness task involved syllable deletion and phoneme deletion. For Chinese and Korean groups, morphological awareness was measured by asking children to form novel compounds for novel objects or concepts based on familiar morphemes. While for the English speaking children, tasks involved novel compound construction and sentence completion with inflected words. Structural equation models showed that for the two Chinese-speaking groups, morphological awareness, but not phonological awareness, significantly predicted word reading after controlling for vocabulary and speeded naming. For the English-speaking group, phonological awareness instead contributed significantly to the children’s reading achievement. The authors concluded that the relative importance of phonological awareness and morphological awareness to reading development depends on the orthography used. However, the phonological awareness tested in the Chinese groups was phoneme or syllable awareness, instead of onset-rime awareness, which has been reported to be a more powerful phonological predictor of word recognition in Chinese (Ho & Bryant, 1997). Therefore the contribution of phonological awareness to Chinese reading might have been underestimated in this study.

Previous research has also provided evidence of the facilitative role of morphological awareness in intermediate and upper primary school children’s reading ability. McBride-Chang et al. (2007) found that morphological awareness was able to explain unique variance in grade 3 children’s reading comprehension after controlling for several reading related skills. Similarly, Shu et al. (2006) studied the contribution of several reading related skills to literacy outcomes among fifth and sixth grade students .They included measures of verbal and visual memory, visual skills, general speed and articulation, to determine which would best distinguish Chinese children with normal reading ability from children with dyslexia. The authors reported that morphological awareness was the most reliable predictor among all those skills even after the effects of vocabulary was statistically removed, and they claimed that it might be the core skill to account for reading disorders in Chinese.

Chow et al. (2008) investigated the effects of morphology training on Chinese children’s reading skills. Hong Kong kindergartners received a variety of tests of Chinese character recognition, vocabulary, morphological awareness, and reading interest. Children were then divided into different groups and experienced twelve weeks of extra tuition. Those children experiencing morphology training as part of the intervention showed the greatest beneficial effect on their character recognition, supporting the contribution of morphological awareness contribution to children’s reading development.

It seems evident that morphological awareness is important to the development of Chinese reading skills due to the nature of the Chinese writing system. Though both morphological and phonological awareness contribute to learning to read Chinese, Morphological awareness of spoken language may be more important to reading Chinese in ways analogous to the importance of phonemic awareness in reading English. As agued by DeFrancis(1989),Word recognition processes in any written language have been shown to be shaped by the nature of the writing system of the language. At the most basic level, the various writing systems of the world's languages map spoken language to written characters in three main ways: alphabetic orthographies map phonemes, the smallest units of sound; syllabic orthographies map syllables, or units of multiple sounds; and logographic/morphographic orthographies map morphemes, the smallest unit of meaning. These fundamental differences in the orthographies of languages may have significant implications for the way that words are recognized in each language and hence the way reading is acquired.

Rapid naming in Chinese reading development

Previous studies have found that rapid naming is predictive of individual differences in reading alphabetic languages (Wagner & Torgesen, 1987). Tasks of rapid naming usually involve naming visual stimuli in a fast and automatic fashion (Hu & Catts, 1998; Wagner & Torgesen, 1987). Rapid naming tasks are also viewed as an important tool for distinguishing normal and disabled readers (Kirby et al.,2003;Wolf & Bowers, 1999). Although rapid naming has not yet been extensively studied in Chinese, existing studies suggest that it does correlate significantly with character recognition. For example, Hu and Catts (1998) reported that rapid naming was more closely related to reading familiar characters than to reading less familiar characters among Taiwanese first grade children. Rapid naming was measured by asking children to name coloured animals in sequence (e.g., red pig, blue cow). Hu and Catts suggested that the primary phonological process in reading familiar characters is the retrieval of phonological codes for visual stimuli.

Similarly, McBride-Chang and Zhong (2003) identified a connection between rapid naming and subsequent reading abilities. In this study, digit naming measured at the age 3 or 4 predicted unique variance in character recognition a year later after age, vocabulary, visual processing skills, speed of processing and the autoregressive effects of time 1 character recognition were statistically controlled. And previous research has also found that rapid naming predicts variation in Chinese reading fluency. Liao (2008) reported that rapid naming explained large amounts (47% and 54%) of unique variance produced by grade 2 and grade 4 readers in a one-minute reading task – and significant levels of prediction were identified after age and IQ were controlled.

However, in Chinese reading research, rapid naming seems to be most useful in identifying those experiencing reading difficulties. Cognitive profiles of Chinese developmental dyslexics suggest that rapid naming may be an efficient screening or diagnostic tool. For example, Ho et al. (2004) concluded that rapid naming deficits were the most dominant type of deficits in Chinese dyslexic children in Hong Kong. In this study, 57% of the dyslexic sample (147 children with a mean age 8 years and 3 months) manifested deficits in rapid naming (naming pictures, colours, and digits). Similarly, Ho et al. (2002) investigated the cognitive profiles of Chinese developmental dyslexics in Hong Kong (mean age 8 years and 8 months). Rapid naming was again the dominant cognitive deficit, as half of the participants demonstrated difficulty on such tasks (naming colours and digits). Ho et at. (2002) concluded that the two core deficits among Chinese dyslexics involve rapid naming and orthographic processing.

Furthermore, rapid naming was found to be an influential factor of reading fluency.

For example, Hu and Catts (1998) reported that rapid naming was more closely related to reading familiar characters than to reading less familiar characters among Taiwanese first grade children. Similarly, a study by Liao et al. (2008) demonstraing a connection between rapid naming and reading flunency. In this study, rapid naming explained large amounts of unique variance produced by grade 2 and grade 4 readers in a word reading fluency task. Such findings implied that rapid naming, requring fast mapping a written form to an oral symbol, appeared to be an essential element of reading fluency.

Rationale for the current research

One potential explanation for the role of phonological awareness in reading Chinese is that experience of learning the phonetic pinyin system supports character decoding (Hu & Catts, 1998; Read et al., 1986): hence good phonological processing leads to better pinyin development which increases acquisition of Chinese character reading. It may also be the case that learning the phonetic pinyin symbols facilitates children's performances on phonological awareness tasks. Phonetic symbols, like letters in alphabetic orthographies, allow readers to have something to associate with sounds, allowing readers to maintain the sounds in working memory. In particular, it has been suggested that low working memory capacities hinder readers' processing of the incoming materials (Gathercole & Baddeley, 1993). However, learning to read Chinese with the aid of a phonetic system is not universal in Chinese instruction. For example, in Hong Kong children learn Chinese characters using a “look and say” method, without the aid of Pinyin – which may help explain some of the differences between findings in mainland China and Hong Kong. Reading Mandarin via a phonetic system (i.e. pinyin in Mainland China) when children start to read might change the relationship between phonological awareness and reading. However, whether well-developed phonological awareness is imperative to young Chinese readers remains unclear.

Equivocal results have been evident from studies of the influence of phonological processing on Chinese reading development. In alphabetic orthographies, graphemes roughly correspond to phonemes. In the Chinese writing system, the basic unit is a character that usually represents one syllable and corresponds to one morpheme. If learning to read involves the recognition of principles underlying a writing system, then phonological processing should be important for alphabetic orthographies whereas morphological awareness may be more important for Chinese. Moreover, the rich morphology of Chinese should influence learning. In mainland China, children learn Chinese characters through being taught the more alphabetic script of Pinyin. Therefore, a more complex relationship between reading, phonological and morphological processing may be predicted, with the influence of the latter two on the former varying with development – as Pinyin becomes less important for decoding, phonological influences may be superseded by morphological.

Hence, the above suggests that both phonological and morphological awareness may be important in learning to read Chinese. Phonological awareness may be important because of its relationship with pinyin and morphological awareness may be important due to its relationship with character processing. Given the differential importance of these two writing systems for Chinese learners, this may suggest that the level of importance will vary with experience. Pinyin is used as the medium of instruction for early learning and, therefore, should show a large influence in early grades, particularly grade 1. However, Chinese character reading becomes more of a focus over grades and, therefore, the influence of morphological processing should grow. The present prediction is that this will happen between grades 2 and 4, so that there may be a mix of influences at grade 2, but by grade 4, morphological processing should exert the dominant influence.

This is the primary focus of the work reported in this thesis, though in addition, rapid naming will be included to investigate the changes in influence of this factor given its current importance in models of reading difficulties in Chinese and hence its potential influence on reading acquisition. If it is an underlying cause of reading problems, then it would be expected to be influential in Chinese character reader from grade 1. In contrast, the role of rapid naming may only become evident when Chinese character reading is dominant and requires fast access to names of visual stimuli. Additionally, the influence of phonological and morphological factors can be better identified by controlling for additional factors, such as rapid naming and vocabulary, both of which will be assessed in the study.

In brief, the research reported in this thesis is guided by the need to re-examine the centrality of phonological awareness and morphological awareness in learning to read Chinese and the need to understand how reading processes in different orthographies are shaped by the nature of the writing system. Given that a great deal of research on Chinese reading development reported in the English language literature has come from Hong Kong where children are taught differently(as discussed in previous section)----Children in Hong Kong are generally taught to read Chinese characters based on rote memory without any phonetic tools, it is possible that different instructional methods between mainland China and Hong Kong (as well as differences in scripts experienced) result in different cognitive processing skills that might be vital for children to achieve reading success at the early stage of Chinese reading development. Hence, research findings derived from studies in Hong Kong may not be representative of mainland China, and more research on children's reading development in the context of teaching in mainland China would be useful to confirm or refine current perspectives on Chinese reading acquisition.

The following main questions will be addressed in the research:

What are the associations between various tasks of phonological awareness, morphological awareness and rapid naming with mainland Chinese children's Pinyin and Chinese characters/text reading abilities?

What is the developmental pattern of the relationships between Chinese children's reading ability and their performance on tests of phonological awareness, morphological awareness and rapid naming?

Chapter 3

Study 1

Phase 1: cross-sectional data from grades 1, 2 and 4

Overview

In the present study, relationships between cognitive-linguistic skills (phonological awareness, morphological awareness and rapid naming) and Chinese reading ability in the initial years of schooling were examined. A cross-sectional design was used in which several cohorts of children were tested from grades one, two and four (roughly 50 per grade). Tests were administered to the children individually by trained assessors in two separate sessions. Children's phonological awareness, receptive vocabulary, morphological processing skills, rapid naming, and reading ability were measured. These tasks were similar to those commonly used in the literature and were designed to take account of the characteristics of the Chinese writing system.

Method

Participants

One hundred and fifty children from a state-funded mainstream school in Beijing, China, participated in this study. The Participants comprised 50 first graders (mean age = 89 months; SD = 5.8), 50 second graders (mean age =102 months; SD = 7.5), and 50 fourth graders (mean age = 128 months; SD = 7.2). They were all native speakers of Mandarin, the official dialect of Mainland China and the language of instruction in schools. Participation in this study was voluntary and based on parental/guardian consent. According to the class teachers' judgments, all children had no behavioral or emotional problems. Owing to the large number of measures used in the current study, some other formal tests of areas such as non-verbal intelligience were not included in order to avoid the over-testing children and problems of dropout children might have during the test. However, PPVT, an estimate of verbal intelligence, was controlled in the study given that individual differences in oral vocabulary have been shown to mediate the relationship between congnitive skills and Chinese reading (Chung & Hu, 2007). Children start school in this context roughly at seven years of age. In mainland China, elementary pupils would receive training in the Pinyin system before they learn to read Chinese characters. It takes about 12 weeks for first-grade children to learn the Pinyin system. Later on, these phonetic symbols will appear alongside Chinese characters in textbooks until the third grade in mainland China. When children reach higher grades (grade 4 and 5), the phonetic symbols are only provided when new characters are introduced.

Procedure

All measures were administered to the children individually by trained examiners in two separate sessions, each lasting about 50 min. In the first session, children's phonological awareness, and receptive vocabulary were assessed, while in the second their morphological processing skills, naming task, and reading ability were measured. Children were tested in a quiet room of school during the second semester of academic year 2013.

Measures

Receptive vocabulary

The Peabody Picture Vocabulary Test-Revised (PPVT-R, Mandarin Version, Lu & Liu, 1998) was used to test children’s general verbal ability. This test is a standardized norm-referenced vocabulary knowledge test developed specifically for Mandarin-speaking children. The testing procedure used in the current study was the one recommended by the manual associated with this Chinese version. In this task, the child was shown panels of four pictures. For each panel, the experimenter named one of the four pictures, and the child was asked to point to the picture that matched the word said by the experimenter. Starting points for children were estimated by their chronological age. From the estimated starting point, the child had to get eight consecutive correct responses. If not, the assessor went back to the previous item until the child got eight consecutive correct responses, and that point was considered as the child's starting point. The test was terminated when the child made six errors in eight consecutive items, and that point was considered as the child's ceiling point. The child was tested from a basal of eight consecutive correct responses to a ceiling of six errors in eight consecutive test words. One point was awarded for each correct response. The raw score was then calculated by subtracting the number of total errors from the number of words attempted before the ceiling was obtained (max = 125). The internal consistency reliabilities reported in the test manual range from .90 to .97.

Rapid Automatic Naming (RAN) measures

Four tasks of speeded naming, namely, picture naming, digit naming, simple character naming, and Pinyin letter naming, developed to assess graphological and nongraphological naming, respectively, were administered individually to children. Time was measured in seconds from the child's pronunciation of the first item until their pronunciation of the last item on the page. Familiarity of names was ensured prior to testing.Following Elbeheri, Everatt, Mahfoudhi, Al-Diyar &Taibah (2011), each task was performed twice, with the first trial being used as practice, due to the use of several naming tasks, and times on the second trial being used as the measure.

Given the use of four measures of rapid naming, evidence for reliability was provided based on the correlations between the four measures. Bivariate correlations among all four RAN measures are reported in Correlation Table below. In general, the four rapid naming measures (RAN Pictures, RAN Digits, RAN Pinyin letters, and RAN Characters) were significantly or highly correlated (rs = .381 to .652) (see Correlation Table below). These results indicated that all four RAN measures mostly tapped on the single underlying cognitive-linguistic skill.

Correlations between all four RAN measures

	Variables	A	B	C
A	Digit naming			
B	Pinyin letter naming	.652**		
C	Character naming	.474**	.397**	
D	Picture naming	.575**	.551**	381**

*** p<.01*

The details of each RAN task are described below:

Digit naming

In this task, five digits, 2, 4, 5, 7, and 9 were equally distributed in a 10 × 5 matrix in random order on a single sheet of paper. The children were then asked to read aloud the digits in a fixed order from beginning to end as accurately and quickly as possible. Time was measured in seconds from the child's pronunciation of the first item until their pronunciation of the last item on the page. This task was performed twice, with the first trial being used as practice and times on the second trial being used as the measure.

Simple Character naming

In this task, five simple characters, 大, 天，少，不，小 that participants would have been highly familiar with based on three primary Chinese language teachers' judgments, were presented in a 10 × 5 matrix in random order on a sheet. Before the formal testing, the children were given a practice trial to ensure the familiarity with the stimuli included in this task.Children were required to read aloud the simple characters in Mandarin from left to right and from top to bottom as accurately and quickly as possible. Similarly, the child was given the task twice, with the first trial being used as practice and times on the second trial being used as the measure.

Pinyin letter naming

Five pinyin letters (b, p, f, n, l,) in Mandarin phonetic system were arranged in a 10 × 5 matrix in random order on a sheet. Children were instructed to say the pinyin letter names from left to right, top to bottom as fast and accurately as possible. A practice trial preceded the formal test trial to make sure the children name the Pinyin sound rather than the English letter name . The task was performed twice, with the first trial being used as practice and times on the second trial being used as the measure. Response time was recorded by a stopwatch.

Picture naming

Six color pictures of common objects (pen, door, key, rabbit, fish, and house) again that are chosen to be highly familiar, distributed with 6 repetitions of each item in random order on a single sheet of paper. A practice trial preceded the test trial to ensure that the children were familiar with the stimuli and gave the same verbal name for each object included in this task.As with the naming task described above, children were asked to name each object from beginning to end at the fastest speed possible for them.The task was given to the child twice, with the first trial being used as practice and times on the second trial being used as the measure. Naming latency was recorded with a stopwatch.

Phonological awareness (PA) measures

The phonological awareness tasks were developed to assess children’s ability to manipulate sounds at syllabic, onset-rime and phonemic levels. Children’s phonological awareness was measured by such tasks as an oddity test , a deletion test and a production test that were commonly used in the literature, both in English and Chinese .

Oddity test was used to assess children’s ability to discriminate sounds at different levels in Chinese syllables. The format of oddity test developed by Bradley & Bryant (1983) was used as a model. In the oddity test, children listened to three syllables or three two-character words presented aloud by the trained assessors, and then were asked to detect the odd one out in terms of syllable, initial phoneme , rime or final phoneme shared by the others. The use of the same tone across initial, rime and final phoneme oddity test avoids the influence of tone on children's task performance.

Deletion task was used to assess children’s ability to analyze and segment sounds at syllabic and phonemic levels. The format of a deletion test developed by McBide-Chang&Ho (2000) was used as a model. In sound deletion test, Children listened to a syllable or a two-syllable word presented aloud by the trained assessors, and then were asked to pronounce what was left after the deletion of a syllable or a single phoneme.

The sound production test was used to assess children's ability to segment a syllable into its consistent phonemes and the ability to create new syllables with the already-segmented phonemes. The format of rhyme production test developed by Chung, McBride-Chang, Wong, Cheung, Penney, & Ho (2008) was used as a model. In the production test, Children were required to produce real new syllables (including the same tone) by using the target sound, such as rhyme units.

In the current study, phonological processing was assessed across a range of processes/levels through the development of nine different measures that examined differing levels or elements of the construct. The phonological awareness measures covered syllable and onset-rime tasks, tone based and phoneme level skills using measures of deletion, discrimination and production. In particular, each level or element of phonological processing was measured using different types of tasks such as deletion and discrimination tests. By including this range of phonological processing, from syllable to individual phonemes, and examining each level by using different types of tasks, the current study provided an extensive set of data to explore the role of phonological processing in Chinese reading development. Furthmore, it is likely that multifaceted phonological awareness index adopted in the current study captured more variability in phonological awareness than previous studies. In the present study, the nine tasks were administered individually. The details of each task are described below.

Syllable deletion

This task was based on a similar task used by Wong et al. (2012).In this test, children were required to delete orally either the first or last syllable from a two-syllable word presented aloud by the assessor. For example, after listening to a two-syllable word [yue4liang4](meaning moon), children were asked to say [yue4liang4] and say it again without the final syllable[liang4] . The right answer, in this case, was [yue4]. There were 2 practice trials and 15 test trials. One point was given for each correct response (max=15). The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was 0.599. Although this is not a high alpha score, this is most likely due to the ceiling effects found in this task among the older children, which will reduce variability in scores and, hence, reliability scores.

Syllable identification

In this task, the experimenter orally presented three two-syllable words to the children and required them to identify the word that was the odd one out in terms of syllable shared by the others. For example, after listening to a set of three two-syllable words [dong1tian1], [dong1gua1], [tan2hua4], children were asked to find the word that did not share the syllable with the others. In this case, the right answer was [tan2hua4]. One point was awarded for each correct response (max=15). The Cronbach's alpha coefficient for the current sample was 0.588. As with the syllable deletion task described above, although this is not a high alpha score, this is most likely due to the ceiling effects found in this task among the older children, which will reduce variability in scores and, hence, reliability scores.

Initial sound identification

This task was developed for the current study to assess children's ability to discriminate the initial sounds of Chinese syllables. In each trial, children were orally presented with a set of three syllables, and then were asked to identify the odd one out that was different in terms of initial sound from the other two. For example, after listening to [ma3], [mai3], [da3], children were asked to choose the syllable that had the different initial sound from the others. The correct answer, in this case, was [da3]. Tones of syllables were controlled so that all three syllables in each trial were in the same tone. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. The odd one out could be the first, second or third item in each trial. One point was awarded for each correct response (max=15).The score was based on the number of correct answers. The

Cronbach's alpha coefficient for the current sample was0.713.

Initial sound deletion

This test was developed to assess children’s ability to segment the initial onset of a Chinese syllable. In each trial, Children were asked to delete orally the initial sound from a heard syllable presented aloud by the assessor. For example, after listening to a syllable [zhang1], children were asked to say [zhang1] and say it again without saying the initial sound [zh] . The right answer, in this case, was [ang]. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. One point was awarded for each correct response (max=15). The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was 0.751.

Final (single) sound identification

This task required children to recognize the final (single/simple) sound of a syllable rather than the final 'compound' units such as /an/, /eng/ in Mandarin and asked them to demonstrate awareness at the single sound level. In this task, children were orally presented with a set of three syllables, and then were asked to identify the odd one that was different in terms of final (single) sound from the other two. For example, after listening to three syllables [san3], [ben3], [mang3], children were asked to identify the syllable that ends with a different (single) sound to all the others. The experimenter was trained to be careful to pronounce the final (single) sound of each syllable in isolation when presenting the syllables to the children. The right answer, in this case, was [mang3]. To avoid the effect of tones on task performance, syllables in each trial were in the same tone. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. The odd one out could be the first, second or third item in each trial. One point was given for each correct response (max = 15). The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was 0.558.

It is interesting to assess Chinese children's sensitivity to unfamiliar linguistic unit, such as the final phoneme, because in the Chinese language those final 'compounds' occur so often and they are represented as a unit bigger than the phoneme level. For example, the compound final pinyin symbol 'ang' is made up of two sounds: [a]and [ŋ]. In Chinese, we teach the unit 'ang''= / aŋ / together as a compound unit despite it consisting of 2 sounds (i.e., two phonemes together). However, it is possible to segment this 'compound' [aŋ] into its constituent parts [a] and [ŋ]. Pinyin system is likely to impact on how children will respond to the task. Through final sound identification and final sound deletion task, we would expect Chinese students who have received literacy instruction in Pinyin to have an even greater dissociation between their ability to isolate first and final phonemes in a word than English children.

Final (single) sound deletion

This task was developed to tap children's awareness of single phonemes at the end of syllables in Mandarin Chinese. In this task, Children were asked to delete orally the final (single) sound from a heard syllable presented aloud by the assessor. For example, after listening to a syllable [huan1], children were asked to say [huan1] and say it again without the final /n/ sound. The experimenter was trained to be careful to pronounce the /n/ in isolation when saying [huan1] to the children. The right answer, in this case, was [hua1]. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. One point was given for each correct response (max=15). The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was 0.686.

Rhyme detection

This task asked children to demonstrate phonological awareness at the rhyme level. In each trial, children were orally presented with three syllables , and were asked to identify the odd one out that did not rhyme with the other two. For example, after listening to three syllables [tan1], [ban1], [dun1], the children were asked to find the syllable that did not rhyme. The right answer was [dun1]. To avoid the effect of tones on children's task performance, all the syllables were assigned the same tone in this task. The odd one out could be the first, second or third item in each trial. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. Children received one point for each correct response. The maximum score was 15. The Cronbach's alpha coefficient for the current sample was0.670.

Rhyme production task

The design of the test was similar to that used in Cantonese by Chung, McBride-Chang, Wong, Cheung, Penney, & Ho (2008).In this task, the experimenter orally presented two Chinese syllables that rhymed, e.g., /fei1/, /bei1/ to the children, and then asked them to produce another real syllable that rhymed with these two within 10 seconds, such as /lei1/, /fei1/, or /hei1/. The fact that all the syllables shared the same tone was also highlighted in testing process. If children provided a syllable that did not exist in Mandarin Chinese, they were then asked to give another answer. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. One point was given for each syllable correctly produced. This task consisted of 2 practice trials and 15 test trials. The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was0.566.

Tone detection

This test was developed for the current study to assess children's ability to discriminate different levels of lexical tones in real Chinese syllables. The task was administered in an “oddity” format, where Children were orally presented with three syllables, and were asked to identify the odd one that was different in terms of tone from the other two. All the syllables included in each trial were designed to differ in both onsets and rimes. For instance, after listening to three syllables [lao2], [tan2], [hai1], children were asked to choose the odd one that had a different tone from the others. The right answer, in this case, was [hai1]. The odd one out could be the first, second or third item in each trial. Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. One point was given for each correct response (max = 15). The Cronbach's alpha coefficient for the current sample was 0.675.

Morphological awareness (MA) tasks

Morphological awareness tasks were constructed to assess children's understanding of meanings and structures of compound words. Four Morphological awareness measures were developed or adapted from tasks in the previous research, specifically, homophone discrimination task from Li et al.(2001) , homograph discrimination task from Ku &Anderson(2003), homograph production task from Shu et al.(2006),and homophone production task created by the current study. In the current study, Characters or words used in the morphological awareness tasks were commonly used and within students' oral vocabulary knowledge based on three primary Chinese language teachers' judgments.

In the current study, morphological awareness covered a range of types of morphological tasks which were used to provide a comprehensive assessment of morphological processing. If morphological processing was involved in Chinese reading, then this range of tasks has a high likelihood of finding relationships with reading skills consistent with their involvement, as well as of dissociating effects on reading across these tasks. Again, it is likely that such a range of multifaceted morphological awareness tasks used in current study captured more variability in morphological awareness than previous studies. These tasks were administered individually. Detailed description of each measure was as follows:

Homophone Discrimination

A homophonic task was developed to tap children's awareness of polyphonic features of Chinese in which characters with the same pronunciations may have different meanings (morphemes) .This task was administered in the "oddity" format and required children to discriminate the morphemes which share the phonological information but differ in meaning or orthographic forms. In this task, three two-character words containing (sharing) a homophonic morpheme were orally presented to children. Children were required to identify the word in which the homophonic morpheme had a different meaning from the others. For example, [hua4] is the homophone in画家 [hua-jia] (painter), 图画 [tu-hua] (picture) and说话 [shuo-hua] (speak), but the [hua4] in 说话 [shuo-hua] (speak) has a different meaning from that in the other two words. The correct answer, in this case, is [shuo-hua] (speak). The position of the homographic morphemes was either at the beginning or at the end of words. Two practice trials were given to children before formal testing to make sure they understood how to perform the task. There was no feedback provided on the test trials. One point was given for each correct response (max = 15). The Cronbach's alpha coefficient for the current sample was 0.716.

Homograph discrimination

The homograph discrimination task, adapted from Ku &Anderson(2003), was developed to tap children's awareness of polysemantic features of Chinese in which one morpheme or character might convey different meanings in different word contexts. Words used in the test were commonly used and within students' oral vocabulary knowledge based on three primary Chinese language teachers' judgments.The task was administered in an “oddity” format, where Children were orally presented with three two-character words, which contained a common morpheme, and were asked to identify the odd word in which the common morpheme conveyed a different meaning from the others. For example, after listening to the words 月光 [yue-guang] (moonlight), 月色[yue-se] (moonbeam), and 年月 [nian-yue] (days), the children were asked to choose the word in which the common part 月 [yue] represented a different meaning from the others. The right answer, in this case, was 年月[nian-yue] (days). The position of homograph morphemes was at the beginning or at the end of the words. This task consisted of 2 practice trials and 15 test trials. If the child got a wrong answer or had no response to the practice trials, the assessor would tell the child the correct answer and demonstrate how to perform it until the child was familiar with the testing procedure. There was no feedback provided on the test trials. The positions of the odd words were counterbalanced across the 15 test trials. Each correct response is scored 1 point, and the maximum score for the task is 15. The Cronbach's alpha coefficient for the current sample was0.803.

Homophone production task

This test was developed for the current study to assess children’s ability to produce different words by using morphemes identical in sounds but different in written forms and meanings. In this task, Children were orally presented with a pair of two-character words, which contained a common syllable (sound), and were required to produce another two-character word by using the common syllable (sound) that represented different meanings (morphemes).For example, After listening to a pair of two-syllable words 树木 [shu4-mu4] (tree) and 目光 [mu4-guang1] (eyesight) , children were required to produce another word by using the common syllable[mu4] that represented different meanings(morphemes). One correct answer, in this case, might be 沐浴 [mu4-yu4] (bath). It would be incorrect if the child produced a word with the same syllable/meaning. For instance, 木头 [mu4-tou4] (wood), in this case, would be an incorrect answer because the syllable [mu4] in 木头 [mu4-tou4] (wood) shares the meaning with [mu4] in 树木 [shu4-mu4] (tree). This task consisted of 2 practice trials and 15 test trials. If the child got a wrong answer or had no response to the practice trials, the assessor would tell the child the correct answer and demonstrate how to perform it until the child was familiar with the testing procedure. One point was given for each word correctly produced. The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was0.679.

Homograph production

This test was created to assess children’s ability to produce different words by using morphemes identical in sounds and written forms but different in meanings. The design of the test was similar to that of Shu et al (2006).In this task, children were orally presented with a pair of two-character words, which contained the common character, and were required to produce another two-character word by using the common character that conveyed different meaning with the other two. For example, After listening to a pair of two-syllable words 朝阳 [zhao-yang] (the rising sun) and 夕阳 [xi-yang] (the setting sun), children were asked to produce another word by using the common character 阳 [yang] that conveyed different meaning. One correct answer, in this case, was 阳刚 [yang-gang] (masculine). It would be incorrect if the child produced a word using the common character that had the same meaning with the others. For instance, 骄阳 [jiao-yang] (the blazing sun), in this case, would be an incorrect answer because the character 阳 [yang] in骄阳 [jiao-yang] (the blazing sun) share the meaning with 阳 [yang] in 朝阳 [zhao-yang] (the rising sun). Two practice trials were given before the test trials to make sure that the children understood the task demands. If the children gave a wrong answer or had no response to the practice trial, they were given the correct answer and told how to perform it. No feedback was provided for the formal testing. One point was given for each word correctly produced. This task consisted of 15 test trials. The score was based on the number of correct answers. The Cronbach's alpha coefficient for the current sample was 0.672.

Reading measures

Consistent with the aim of providing a range of measures of processing skills, the study also incorporated a range of reading tasks. Chinese reading abilities were assessed by Pinyin reading, Chinese character reading, Nonsyllable reading and Nonword reading. The assessment of a range of reading skills increased the chance of identifying relationships, but also provided the potential to examine whether different underlying processes played different roles across different types of reading skills. Again, the aim of the present research was to provide a broader set of data on the target variables than provided by existing studies, through which to inform theory and practice. Surprisingly, few studies (particularly reported in the English language literature) have considered the involvement of Pinyin reading and its potential influence on the relationships between phonological, morphological and naming processes and literacy development. The present study specifically included measures of reading in Pinyin and in Chinese characters to investigate evidence for differences in the underlying processes that support logographic-based (Chinese character) and alphabetic-based script (Pinyin) literacy acquisition in one language (i.e., Chinese).

Four tests, developed to assess children's reading abilities, were administered individually. Given that the four measures are measures of reading skills, evidence for reliability of all four measures was provided based on the correlations between the four measures. Bivariate correlations among all four reading measures are reported in Correlation Table Below. In general, the four reading measures (Pinyin reading, Chinese character reading, Nonsyllable reading and Nonword reading) were significantly or highly correlated (rs = .466 to .878) (see Correlation Table Below). These results indicated that all four reading measures mostly tapped on the single underlying linguistic skill. The details of each reading task are described below:

Correlations between all four reading measures

	Variables	A	B	C
A	Pinyin reading			
B	Character reading	.490**		
C	Nonword reading	.500**	.878**	
D	Nonsyllable reading	.787**	.466**	.503**

*** p<.01*

Character Reading

Two tasks of single character and two-character word reading were combined to make this task sufficiently broad so that the first, second and fourth graders could be given the same character recognition list. The list began with 60 single Chinese characters and followed by 60 two-character words, increasing in difficulty. Items were arranged in rows of ten characters or five words each on two separate sheets, with increasing difficulty. Given that there was no standardized reading test available in Mainland China, this task was developed by selecting characters or words from the 12 volumes of the Primary School Textbooks (elementary Chinese curriculum research and development center 2012) used in primary Chinese language curricula in Mainland China. For 1st-, 2nd-, and 4th-graders, about 1/4 of characters and words selected were grade matched respectively, while the remaining 1/4 appeared in more advanced grade-level textbooks. In this test, children were required to read aloud the single characters and two-character words as accurately as possible. Across grade levels, children were asked to read from the beginning of the test. To avoid potential frustration and tiredness the child may have during the test, the task was discontinued when the child made 15 consecutive errors. One point was awarded for each character or word correctly read. The total number of characters and words correctly identified was counted as the character reading score. The maximum score was 120 for all graders.

Examples of Character Reading

Single Character Reading	Two-Character Word Reading
舟 爪 钟 虾	高级　行李　机会　友人

Pinyin Reading

This test was developed to assess children’s pinyin reading proficiency by requiring them to read Pinyin syllables printed on a sheet which included 50 single syllables and 25 two-syllable words in Pinyin script. All grades were given the same stimuli. Subjects were asked to read the Pinyin aloud as quickly and accurately as possible. To avoid potential frustration and tiredness the child may have during the test, the task was discontinued when the child made 15 consecutive errors. One point was given for each single syllable or two-syllable word pronounced correctly. No partial marking was given when only one syllable in a two-syllable word was pronounced correctly.

The number of pinyin syllables that children could correctly pronounce was counted and the total score was 75.

Examples of Pinyin Reading

One-syllable Pinyin Reading	Two-syllable word Pinyin Reading
báo zhōng	jīqì túdì

Non-Syllable Reading

Pseudo-syllable naming test was constructed to assess children’s phonetic coding ability of Pinyin system. In this task, Children were required to read 30 non-syllables written in pinyin that were printed on a sheet. Each of the syllables in the task possessed a legitimate blending of an onset and a rhyme with or without a medial in the Chinese phonology system. For example, syllable [bou] consists of onset[b] and rhyme [ou]; however, this made-up syllable did not exist in the Mandarin dialect. Children were encouraged to do their best to read out those made-up syllables in Pinyin with either one of the four tones in Mandarin Chinese .In this task, Children were told that they were given some made-up but pronounceable syllables ,and were asked to read aloud correctly and rapidly each pseudo-syllable. Consistent with the previous measures, the test was discontinued when the child made 15 consecutive errors to avoid potential frustration and tiredness the child may have during the test. Two practice items were presented before the formal testing to make sure children understood how to perform the task properly. One point was given for each pseudo-syllable accurately pronounced and the maximum score was 30.

Examples of Non-Syllable Reading

mia	buong	fing	mun

Nonword reading

The non-word reading task consisting of 40 items was constructed to assess children’s ability to identify Chinese nonwords. In this task, two-character Chinese nonwords were used, in which each of the two constituent characters has a pronunciation and meaning, but their combination produced a pronounceable, meaningless Chinese non-word. Each nonsense word was a compound of two characters that did not produce an existing word in the Chinese language. For example, 学屋 (xue2wu1) is a non-word in which each character has its own meaning, but their combination produced a nonsense word. This task was designed to taken into account of the linguistic properties of constituent characters such as character frequency, complexity of strokes and the percentage rate of phonograms.

In this task, Children were told that they were given some ill-formed but pronounceable words, and were asked to read aloud accurately and quickly each two-character nonsense word printed on a sheet. Consistent with the previous measures, the task was discontinued when the child made 15 consecutive errors during the test to avoid potential frustration and tiredness. Two practice items were presented before the formal testing to make sure children understood the task demand properly. One point was given for each nonsense word accurately pronounced. If only one character in a nonword was read out correctly, 0 point was given. The maximum score was 40.

Examples of Non-Word Reading

生友	走学	本上	天飞	月见	光可	水方	周者

Results and Discussion

Descriptive Statistics

Descriptive statistics including the means, standard deviations, minimum and maximum scores on each test for grades 1, 2 and 4 are presented in Tables 3.1 to 3.4. Generally, it was found that the performance improved across grade levels: performance by the older cohort was faster on RAN tasks and better on all other measures than that of their younger counterparts. Although the performance on syllable deletion task for the two older groups were the same, indicating a ceiling effect, across most groups, there was adequate variability on all measures.

Table 3.1. Descriptive statistics of PA measures for grade 1, 2 and 4 in study 1

Grade		Syllable deletion	Syllable identification	Initial sound identification	Initial sound deletion	Final sound identification	Final sound deletion	Rhyme identification	Rhyme production	Tone identification
1	Mean	14.54	12.74	9.86	12.24	7.42	6.52	8.62	9.94	11.94
	SD	0.95	2.22	3.21	2.71	2.68	3.05	3.17	2.44	2.85
	Min	11	6	3	5	2	1	2	2	4
	Max	15	15	15	15	13	13	15	15	15
2	Mean	15	13.1	10.3	12.42	7.46	6.52	8.78	10.3	12.14
	SD	0	1.96	3.35	3.21	2.73	3.3	3.09	2.74	2.7
	Min	15	7	3	5	2	0	2	5	5
	Max	15	15	15	15	13	15	15	15	15
4	Mean	15	13.8	11.16	13.28	7.84	7.06	9.84	10.5	12.5
	SD	0	1.07	2.51	1.28	2.29	2.54	2.87	2.54	1.79
	Min	15	11	4	11	0	0	2	4	8
	Max	15	15	15	15	12	13	15	15	15

Table 3.2. Descriptive statistics of MA measures for grade 1, 2 and 4 in study 1

Grade		Homophone discrimination	Homograph discrimination	Homophone production	Homograph production
1.00	Mean	5.06	6.26	6.28	6.50
	SD	3.22	3.58	2.98	3.07
	Min	.00	.00	1.00	1.00
	Max	12.00	15.00	14.00	13.00
2.00	Mean	7.74	7.26	7.82	7.36
	SD	2.83	4.27	3.06	2.90
	Min	3.00	1.00	3.00	1.00
	Max	15.00	15.00	14.00	15.00
4.00	Mean	9.24	10.16	10.04	9.80
	SD	2.50	2.29	2.00	2.35
	Min	4.00	3.00	7.00	5.00
	Max	15.00	15.00	15.00	15.00

Table 3.3. Descriptive statistics of RAN measures for grade 1, 2 and 4 in study 1

Grade		Digit naming	Pinyin letter naming	Character naming	Picture naming
1.00	Mean	26.30	45.48	36.30	35.14
	SD	5.29	11.47	10.28	7.09
	Min	13.00	30.00	25.00	23.00
	Max	38.00	91.00	72.00	49.00
2.00	Mean	25.92	43.32	31.06	32.06
	SD	6.76	11.21	7.53	7.83
	Min	13.00	23.00	19.00	20.00
	Max	42.00	60.00	54.00	59.00
4.00	Mean	19.78	32.74	30.96	23.82
	SD	4.80	6.42	6.70	6.55
	Min	12.00	21.00	17.00	14.00
	Max	34.00	54.00	44.00	39.00

Table 3.4. Descriptive statistics of reading measures and vocabulary for grade 1, 2 and 4 in study 1

grade		Pinyin reading	Character reading	Nonword reading	Nonsyllable reading	Receptive vocabulary
1.00	Mean	63.50	64.96	19.66	22.26	71.00
	SD	11.55	17.32	5.10	4.99	7.18
	Min	30.00	30.00	9.00	8.00	56.00
	Max	75.00	92.00	27.00	30.00	84.00
2.00	Mean	64.32	78.42	23.34	23.40	76.46
	SD	10.96	12.21	4.15	5.80	12.68
	Min	30.00	54.00	12.00	5.00	46.00
	Max	75.00	106.00	32.00	30.00	104.00
4.00	Mean	65.98	89.86	30.28	23.48	90.92
	SD	7.67	13.97	6.21	4.26	9.04
	Min	40.00	66.00	15.00	13.00	74.00
	Max	75.00	119.00	40.00	30.00	117.00

Correlations among measures

Grade1

Bivariate correlations among all measures for Grade 1 are reported in Tables 3.5 to 3.9. Tables 3.5 to 3.8 present correlations within construct skills for Grade 1 participants. In general, the four reading measures (Character Reading , Pinyin Reading, nonword reading, nonsyllable reading) were significantly or highly correlated (rs=.493 to .881) (see Table 3.8). Among the nine phonological awareness measures (Syllable deletion, syllable identification, Initial sound identification, Initial sound deletion, Final sound identification, Final Sound Deletion, Rhyme identification, Rhyme production, and Tone identification) correlations ranged from moderate to highly significant (rs=.133 to .793) (see Table 3.5). The four rapid naming measures (RAN Pictures, RAN Digits, RAN Pinyin letters, and RAN Characters) were moderately to highly correlated (rs =.246 to .582) (see Table 3.7). Finally, the four MA tasks (Homophone discrimination, Homograph discrimination, Homophone production, and Homograph production) showed significant or high correlations with each other (rs=.303 to .756) (Table 3.6). These results indicated that measures within each construct mostly tapped on the single underlying cognitive-linguistic skill.

Table 3.9 presents the correlations between two reading measures, namely, character reading and pinyin reading, and all other measures administered to Grade 1 participants. Overall, Character Reading correlated significantly with most cognitive processing measures, with the exception of Homophone Discrimination (r =.204). Character Reading was moderately to strongly associated with PA measures (rs =.339 to .660) , RAN measures (rs= -.396 to -.546), and moderately correlated with MA (rs=.204 to .486) . Within the reading measures, Character reading correlated highly with Nonword Reading (r=.881), suggesting that these two reading tasks tap a single reading skill. The relationship between receptive vocabulary and character reading was significant (r=.356). Interestingly, both Pinyin Reading and Nonsyllable reading were strongly associated with character reading (for Pinyin Reading, r = .575; for nonsyllable reading, r = .493).

Pinyin reading, in turn, is correlated significantly with most measures, with the exception of Final Sound Deletion (r=.278). Overall, Pinyin Reading was significantly associated with PA measures (rs=.404 to .834), RAN measures (rs= -.371 to -.630), and moderately correlated with MA (rs=.348 to .417). Within the reading measures, Pinyin reading correlated highly with Nonsyllable Reading (r =.815), suggesting that these two reading tasks tap a single reading skill. The relationship between receptive vocabulary and pinyin reading was significant (r =.399) and a significant correlation was found between Pinyin reading and Nonword reading (r =.633).

Table 3.5. Correlations between Grade 1 Phonological Measures

	Variables	A	B	C	D	E	F	G	H
A	Syllable deletion								
B	Syllable identification	.647**							
C	Initial sound identification	.559**	.793**						
D	Initial sound deletion	.337*	.527**	.637**					
E	Final sound identification	.133	.259	.471**	.402**				
F	Final sound deletion	.133	.322*	.364**	.197	.628**			
G	Rhyme identification	.427**	.507**	.635**	.514**	.492**	.356*		
H	Rhyme production	.312*	.324*	.355*	.24	.368**	.391**	.589**	
I	Tone identification	.336*	.530**	.593**	.632**	.359*	.284*	.592**	.451**

* *p<.05; ** p<.01*

Table 3.6. Correlations between grade 1 morphological measures

	Variables	A	B	C
A	Homophone discrimination			
B	Homograph discrimination	.580**		
C	Homophone production	.324*	.545**	
D	Homograph production	.303*	.512**	.756**

* *p<.05; *** *p<.01*

Table 3.7. Correlations between grade 1 RAN measures

	Variables	A	B	C
A	Digit naming			
B	Pinyin letter naming	.582**		
C	Character naming	.380**	.246	
D	Picture naming	.570**	.557**	.253

* *p<.05; *** *p<.01*

Table 3.8. Correlations between grade 1 reading measures and vocabulary

	Variables	A	B	C	D
A	Pinyin reading				
B	Character reading	.575**			
C	Nonword reading	.633**	.881**		
D	Nonsyllable reading	.815**	.493**	.557**	
E	Receptive vocabulary	.399**	.356*	.380**	.244

* *p<.05; *** *p<.01*

Table 3.9. Correlations between two reading measures and all other measures in study 1 for grade 1 children

	Character reading	Pinyin reading
Syllable Deletion	.490**	.637**
Syllable Identification	.660**	.646**
Initial Sound Identification	.581**	.834**
Initial Sound Deletion	.574**	.672**
Final Sound Identification	.339*	.404**
Final Sound Deletion	.370**	.278
Rhyme Identification	.597**	.741**
Rhyme Production	.462**	.470**
Tone Identification	.606**	.606**
Homophone Discrimination	.204	.348*
Homograph Discrimination	.378**	.377**
Homophone Production	.486**	.417**
Homograph Production	.453**	.385**
Digit Naming	-.522**	-.630**
Pinyin Letter Naming	-.396**	-.420**
Character Naming	-.443**	-.371**
Picture Naming	-.546**	-.610**
Nonword Reading	.881**	.633**
Nonsyllable Reading	.493**	.815**
Receptive Vocabulary	.356*	.399**
Character Reading		.575**

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

Grade 2

Tables 3.10 to 3.13 present correlations within construct skills for Grade 2 participants. In general, the four reading measures (Character Reading , Pinyin Reading, nonword reading, nonsyllable reading) were significantly or highly correlated (rs=.467 to .897) (Table 3.13). Among the nine phonological awareness measures (Syllable deletion, syllable identification, Initial sound identification, Initial sound deletion, Final sound identification, Final Sound Deletion, Rhyme identification, Rhyme production, and Tone identification) the correlations ranged from moderate to highly significant (rs=.305 to .756) (Table 3.10). The four rapid naming measures (RAN Pictures, RAN Digits, RAN Pinyin letters, and RAN Characters) were moderately to highly correlated (rs = .281 to .720) (Table 3.12). The four MA tasks (Homophone discrimination, Homograph discrimination, Homophone production, and Homograph production) showed significant or high correlations with each other (rs=.226 to .663) (Table 3.11). These results indicated that measures within each construct skill mostly tapped on the single underlying linguistic skill.

Table 3.14 presents the correlations between two reading measures, namely, character reading and pinyin reading, and all other measures administered to Grade2 children. Character Reading correlated significantly with most cognitive processing measures, with the exception of Homophone production (r=.275). Overall, Character Reading was moderately to strongly associated with PA measures (rs=.333 to .705), RAN measures (rs= -.379 to -.689), and moderately correlated with MA (rs=.275 to .501).

Within reading measures, Character reading correlated highly with Nonword Reading (r=.762), indicating that these two reading tasks tap a single reading skill. The relation between receptive vocabulary and character reading was significant (r=.430). Both Pinyin Reading and Nonsyllable reading were strongly associated with character reading (for Pinyin Reading, r=.590; for nonsyllable reading, r=.467). Pinyin reading, in turn, correlated significantly with all the phonological processing measures and RAN measures, whereas none of the morphological measures correlated significantly with Pinyin reading (rs = .077 to .256). Pinyin Reading was moderately to strongly associated with PA measures (rs = .380 to .635), RAN measures (rs= -.484 to -.737). Within the reading measures, Pinyin reading correlated highly with Nonsyllable Reading (r=.897), indicating that these two reading tasks tap a single reading skill. The relation between receptive vocabulary and pinyin reading was significant (r=.493) and a significant correlation was found between Pinyin reading and Nonword reading (r =.716).

Table 3.10. Correlations between Grade 2 Phonological Measures

	Variables	A	B	C	D	E	F	G	H
A	Syllable deletion	.[a]							
B	Syllable identification	.[a]							
C	Initial sound identification	.[a]	.756**						
D	Initial sound deletion	.[a]	.602**	.714**					
E	Final sound identification	.[a]	.535**	.492**	.305*				
F	Final sound deletion	.[a]	.625**	.539**	.310*	.694**			
G	Rhyme identification	.[a]	.607**	.689**	.524**	.491**	.510**		
H	Rhyme production	.[a]	.579**	.643**	.448**	.487**	.465**	.724**	
I	Tone identification	.[a]	.686**	.581**	.343*	.320*	.485**	.608**	.611**

** p<.05; ** p<.01; [a] indicates no variability in the syllable deletion task*

Table 3.11. Correlations between Grade 2 Morphological Measures

	Variables	A	B	C
A	Homophone discrimination			
B	Homograph discrimination	.447**		
C	Homophone production	.377**	.549**	
D	Homograph production	.226	.663**	.445**

* *p<.05; *** *p<.01*

Table 3.12.Correlations between Grade 2 RAN Measures

	Variables	A	B	C
A	Digit naming			
B	Pinyin letter naming	.608**		
C	Character naming	.720**	.632**	
D	Picture naming	.369**	.281*	.450**

* *p<.05; *** *p<.01*

Table 3.13. Correlations between Grade 2 Reading Measures and vocabulary

	Variables	A	B	C	D
A	Pinyin reading				
B	Character reading	.590**			
C	Nonword reading	.716**	.762**		
D	Nonsyllable reading	.897**	.467**	.680**	
E	Receptive vocabulary	.493**	.430**	.500**	.369**

* *p<.05; *** *p<.01*

Table 3.14. Correlations between two reading measures and all other measures in study 1 for grade 2 children

	Character Reading	Pinyin Reading
Syllable Deletion	.[a]	.[a]
Syllable Identification	.490**	.546**
Initial Sound Identification	.555**	.584**
Initial Sound Deletion	.386**	.635**
Final Sound Identification	.333*	.380**
Final Sound Deletion	.444**	.464**
Rhyme Identification	.705**	.631**
Rhyme Production	.534**	.410**
Tone Identification	.524**	.555**
Homophone Discrimination	.501**	.256
Homograph Discrimination	.430**	.138
Homophone Production	.275	.077
Homograph Production	.312*	.179
Digit Naming	-.554**	-.737**
Pinyin Letter Naming	-.379**	-.522**
Character Naming	-.507**	-.637**
Picture Naming	-.689**	-.484**
Nonword Reading	.762**	.716**
Nonsyllable Reading	.467**	.897**
Receptive Vocabulary	.430**	.493**
Character Reading		.590**

** p<.05; ** p<.01;* [a] *indicates no variability in the syllable deletion task*

Grade 4

Tables 3.15 to 3.18 present correlations within construct skills for Grade 4 participants. In general, the four reading measures (Character Reading, Pinyin Reading, nonword reading, nonsyllable reading) were significantly or highly correlated (rs =.420 to .846). Among nine phonological awareness measures (Syllable deletion, syllable identification, Initial sound identification, Initial sound deletion ,Final sound identification, Final Sound Deletion, Rhyme identification ,Rhyme production, and Tone identification) correlations ranged from nonsignificant to highly significant (rs=-.052 to .520). The four rapid naming measures (RAN Pictures, RAN Digits, RAN Pinyin letters, and RAN Characters) were moderately to significantly correlated (rs=.204 to .392). The four MA tasks (Homophone discrimination, Homograph discrimination, Homophone production, and Homograph production) showed significant or high correlations with each other (rs =.317 to .533), suggesting that these tasks mostly tapped on the same underlying construct skill.

Table 3.19 presents the intercorrelations between two reading measures, namely, character reading and pinyin reading, and all other measures administered to Grade 4 children. Character Reading correlated significantly with all the morphological processing measures (rs=.471 to .615). Character Reading showed variable associations with PA measures (rs = .183 to .427) and moderately to highly correlated with RAN (rs=-.188 to-.467). In general, the morphological measures correlated higher with the character reading than phonological measures.

Within the reading measures, Character reading correlated highly with NonwordReading (r=.846), indicating that these two reading tasks tap a single reading skill The relationship between receptive vocabulary and character reading was significant (r=.464), and both Pinyin Reading and Nonsyllable reading were significantly associated with character reading (for Pinyin Reading, r=.420; for nonsyllable reading, r=.600). Pinyin reading, in turn, only correlated significantly with two phonological measures, intial sound identification (r=.427) and tone identification (r=.415), but it did not correlate significantly with any of the morphological measures. Of the RAN skills, only Pinyin letter naming significantly correlated with Pinyin reading (r= -.296). And, within the reading measures, Pinyin reading correlated highly with Nonsyllable Reading (r=.548). The relation between receptive vocabulary and pinyin reading was not significant (r=.097), though a significant correlation was found between Pinyin reading and Nonword reading (r =.456).

Table 3.15. Correlations between Grade 4 Phonological Measures

	Variables	A	B	C	D	E	F	G	H
A	Syllable deletion	.[a]							
B	Syllable identification	.[a]							
C	Initial sound identification	.[a]	.05						
D	Initial sound deletion	.[a]	.281*	-.052					
E	Final sound identification	.[a]	-.138	.520**	-0.04				
F	Final sound deletion	.[a]	-.003	.462**	.032	.415**			
G	Rhyme identification	.[a]	.255	.400**	.24	.235	.239		
H	Rhyme production	.[a]	.255	.502**	.038	.239	.292*	.447**	
I	Tone identification	.[a]	.118	.482**	0	.279*	.155	.246	.204

** p<.05; ** p<.01; [a] indicates no variability in the syllable deletion task*

Table 3.16. Correlations between Grade 4 Morphological Measures

	Variables	A	B	C
A	Homophone discrimination			
B	Homograph discrimination	.317*		
C	Homophone production	.430**	.453**	
D	Homograph production	.533**	.420**	.476**

* *p<.05; *** *p<.01*

Table 3.17. Correlations between Grade 4 RAN Measures

	Variables	A	B	C
A	Digit naming			
B	Pinyin letter naming	.387**		
C	Character naming	.294*	.204	
D	Picture naming	.392**	.304*	.329*

* *p<.05; *** *p<.01*

Table 3.18.Correlations between Grade 4 Reading Measures and vocabulary

	Variables	A	B	C	D
A	Pinyin reading				
B	Character reading	.420**			
C	Nonword reading	.456**	.846**		
D	Nonsyllable reading	.548**	.600**	.607**	
E	Receptive vocabulary	.097	.464**	.400**	.324*

* *p<.05; *** *p<.01*

Table 3.19. Correlations between two reading measures and all other measures in study 1 for grade 4 children

	Character Reading	Pinyin Reading
Syllable Deletion	.[a]	.[a]
Syllable Identification	.183	.102
Initial Sound Identification	.291*	.427**
Initial Sound Deletion	.283*	.250
Final Sound Identification	.212	.177
Final Sound Deletion	.339*	.268
Rhyme Identification	.427**	.270
Rhyme Production	.374**	.214
Tone Identification	.349*	.415**
Homophone Discrimination	.471**	.101
Homograph Discrimination	.615**	.254
Homophone Production	.472**	.180
Homograph Production	.499**	.164
Digit Naming	-.306*	-.237
Pinyin Letter Naming	-.188	-.296*
Character Naming	-.467**	-.130
Picture Naming	-.464**	-.215
Nonword Reading	.846**	.456**
Nonsyllable Reading	.600**	.548**
Receptive Vocabulary	.464**	.097
Character Reading		.420**

**. P<0.01 . *. P<0.05*;* [a] *indicates no variability in the syllable deletion task*

Unique predictors of Concurrent Character Reading and Pinyin Reading

The predictor variables of interest in this study were related to 17 tasks, which fell into the three constructs: phonological awareness (PA), morphological awareness (MA) and RAN. To examine the unique contributions of the two awareness variables to Chinese character reading and Pinyin reading respectively, hierarchical regression analyses were performed with Chinese Character Reading as the measure to be predicted in the first run, while the same analyses were performed with Pinyin Reading as dependent variable in the second run. In each run, age & gender, receptive vocabulary, rapid naming were entered in steps 1 to 3. The two awareness variables were entered as the last two steps in each of the regression models to examine their unique contributions to Chinese Character Reading and Pinyin Reading respectively. Results from these regressions were presented in Tables 3.20 to 3.25.

Character Reading

The regression results for Grade 1 Chinese Character Reading were presented in Table 3.20. As shown in Table 3.20(i), when entered as the last step, phonological explained 14.5% additional variance in Chinese reading at grade 1 beyond the contributions of morphological awareness and other relevant variables. In contrast, Table 3.20(ii) shows that morphological awareness explained 2.6% of unique variability in Chinese reading beyond the contributions of morphological awareness and the other control variables.

To investigate the role of RAN in grade 1 character reading, another hierarchical regression analysis was run with RAN measures entered as the last step. As shown in Table 3.20(iii), when entered as the last step, RAN explained 4.1% additional variance in Chinese reading at grade 1 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

In the above regression models, the variables which are likely to make important contributions to Grade 1 concurrent Chinese character reading have been identified. The results indicated that phonological awareness made the greatest contribution to Chinese character reading, while morphological awareness did not.

Table 3.20. Hierarchical Linear Regressions Predicting Concurrent Grade 1 Character Reading

	Steps& variables	R^2	R^2 change	Sig R^2change	Final Beta	
1	Gender & Age	.007	.007	F(2,47) =.156 p= .856	Gender	.015
					Age	.112
2	Receptive vocabulary	.137	.131	F(1,46)=6.966 p =.011	Receptive vocabulary	.123
i						
3	RAN skills	.462	.325	F(4,42)=6.339 p =.000	Picture naming	-.213
					Character naming	-.092
					Pinyin letter naming	.158
					Digit naming	-.120
4	MA skills	.572	.110	F(4,38)=2.430 p =.064	Homograph production	.027
					Homophone discrimination	-.065
					Homograph discrimination	.203
					Homophone production	.071
5	PA skills	.717	.145	F(9,29)=1.657 p =.146	Rhyme production	.155
					Syllable deletion	.031
					Final sound deletion	.091
					Tone identification	.110
					Final sound identification	-.026
					Initial sound deletion	.197
					Initial sound identification	-.383
					Rhyme identification	.200
					Syllable identification	.331
ii						
3	RAN skills	.462	.325	F(4,42)=6.339 p =.000		
4	PA skills	.691	.229	F(9,33)=2.710 p =.018		
5	MA skills	.717	.026	F(4,29) =.678 p =.613		
iii						
3	PA skills	.633	.495	F(9.37)=5.547 p =.000		
4	MA skills	.677	.044	F(4,33)=1.118 p =.364		
5	RAN skills	.717	.041	F(4,29)=1.038 p =.404		

Table 3.21 presents the results from the regression analyses conducted to determine the unique predictors of concurrent character reading for Grade 2 children. As shown in Table 3.21(i), when entered as the last step, phonological explained 15.1% additional variance in Chinese reading at grade 2 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained 12.9% of unique variability in Chinese reading beyond the contributions of morphological awareness and the other control variables (Table 3.21(ii)).

As shown in Table 3.21(iii), when entered as the last step, RAN explained 11.1% additional variance in Chinese reading at grade 1 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

These regression results indicated the joint contribution of phonological awareness (PA), morphological awareness (MA) and RAN to Chinese character reading in Grade 2. Such findings are more consistent with previous research (e.g., Ho et al.2003; Shu et al. 2006).

Table 3.21. Hierarchical Linear Regressions Predicting Concurrent Grade 2 Character Reading

	Steps& Variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.001	.001	F(2,47) =.027 p =.974	Gender Age	.090 .015
2	Receptive vocabulary	.205	.204	F(1,46) = 11.77 p=.001	Receptive vocabulary	.114
i						
3	RAN skills	.591	.386	F(4,42) = 9.921 p =.000	Picture naming Character naming Pinyin letter naming Digit naming	-.364 -.228 .190 -.018
4	MA skills	.690	.099	F(4,38) = 3.018 p =.030	Homophone discrimination Homograph production Homograph discrimination Homophone production	.248 -.055 .271 .182
5	PA skills	.841	.151	F(8,30) =3.559 p =.005	Final sound identification Rhyme production Tone identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	-.310 -.272 .117 .114 .027 .252 .538 -.360
ii						
3	RAN skills	.591	.386	F(4,42) =9.921 p =.000		
4	PA skills	.712	.121	F(8,34) =1.779 p =.116		
5	MA skills	.841	.129	F(4,30) =6.079 p =.001		
iii						
3	PA skills	.552	.347	F(8,38) =3.683 p =.003		
4	MA skills	.73	.178	F(4,34) =5.607 p =.001		
5	RAN skills	.841	.111	F(4,30) =5.215 p =.003		

Table 3.22 presents the results from the regression analyses conducted to determine the unique predictors of concurrent character reading for Grade 4 children. As shown in Table 3.22(i), when entered as the last step, phonological explained 7.3% additional variance in Chinese reading at grade 4 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained 17.1% of unique variability in Chinese reading beyond the contributions of morphological awareness and the other control variables (Table 3.22(ii)). And, as shown in Table 3.22(iii), when entered as the last step, RAN explained 7.4% additional variance in Chinese reading at grade 4 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

These results indicated that for Grade 4 children, morphological awareness made the greatest significant contribution to Chinese character reading, with rapid naming as the second contributor, while phonological awareness did not made the significant contribution to Chinese character reading.

Table 3.22. Hierarchical Linear Regressions Predicting Concurrent Grade 4 Character Reading

	Steps& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.038	.038	F(2,47) =.923 p =.404	Gender Age	.215 .231
2	Receptive vocabulary	.241	.204	F(1,46) =12.354 p =.001	Receptive vocabulary	.223
i						
3	RAN skills	.435	.193	F(4,42) =3.593 p =.013	Picture naming Character naming Pinyin letter naming Digit naming	-.328 -.074 -.104 .026
4	MA skills	.663	.228	F(4,38) = 6.436 p =.000	Homophone discrimination Homograph production Homograph discrimination Homophone production	.275 .374 .277 -.031
5	PA skills	.736	.073	F(8,30) =1.029 p =.436	Final sound identification Rhyme production Tone identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	.362 .052 .211 -.061 -.143 -.397 -.107 .008
ii						
3	RAN skills	.435	.193	F(4,42) =3.593 p =.013		
4	PA skills	.565	.130	F(8,34) =1.272 p =.290		
5	MA skills	.736	.171	F(4,30) =4.84 p =.004		
iii						
3	PA skills	.460	.218	F(8,38) =1.92 p=.085		
4	MA skills	.662	.202	F(4,34) =5.069 p =.003		
5	RAN skills	.736	.074	F(4,30) = 2.101 p =.105		

Pinyin Reading

To examine the relative contributions of phonological awareness, morphological awareness and RAN to Pinyin reading, hierarchical regressions were performed in the same way as that for Chinese character reading. Results from the regression analyses were summarized in Tables 3.23 to 3.25.

Table 3.23 presents the results of regression analyses predicting concurrent Grade1 Pinyin Reading. When entered as the last step, phonological explained 29% additional variance in Pinyin reading at grade 1 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained only 1% of unique variability in Pinyin reading beyond the contributions of morphological awareness and the other control variables. Furthermore, when entered as the last step, RAN explained 4.8 % additional variance in Pinyin reading at grade 1 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

These results indicated that phonological awareness made the greatest significant concurrent contribution to Pinyin reading in grade 1, with rapid naming also making a contribution, but morphological awareness did not.

Table 3.23. Hierarchical Linear Regressions Predicting Concurrent Grade 1 Pinyin Reading

	Steps& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.037	.037	F(2,47)=.913 p=.408	Gender Age	. 008 .028
2	Receptive vocabulary	.223	.185	F(1,46)=10.966 p=.002	Receptive vocabulary	-.051
i						
3	RAN skills	.528	.305	F(4,42)=6.776 p =.000	Picture naming Character naming Pinyin letter naming Digit naming	-.212 -.088 .130 -.167
4	MA skills	.624	.096	F(4,38)=2.430 p =.064	Homophone discrimination Homograph production Homograph discrimination Homophone production	.051 .059 -.085 -.140
5	PA skills	.913	.290	F(9,29)=10.779 p=.000	Final sound identification Rhyme production Ton identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification Syllable deletion	-.102 .014 .044 .017 .122 .662 .216 -.266 .246
ii						
3	RAN skills	.528	.305	F(4,42)=6.776 p =.000		
4	PA skills	.904	.376	F(9,33)=14.341 p =.000		
5	MA skills	.913	.010	F(4,29) =.805 p=.532		
iii						
3	PA skills	.853	.630	F(9,37)=17.562 p=.000		
4	MA skills	.866	.013	F(4,33)=.797 p =.536		
5	RAN skills	.913	.048	F(4,29)=4.010 p =.010		

Table 3.24 presents the results of regression analyses predicting concurrent Grade 2 Pinyin Reading. Phonological awareness explained 15.4% additional variance in Pinyin reading at grade 2 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained only 0.6% of unique variability in Pinyin reading beyond the contributions of morphological awareness and the other control variables. And RAN explained 9.2% additional variance in Pinyin reading at grade 2 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

These findings indicated that phonological awareness made the greatest significant concurrent contribution to Pinyin reading, with rapid naming second, while morphological awareness made the least contribution to Pinyin reading in Grade 2.

Table 3.24. Hierarchical Linear Regressions Predicting Concurrent Grade 2 Pinyin Reading

	variables	R^2	R^2 change	Sig R^2change	Final Beta	
1	Gender & Age	.005	.005	F(2,47)=.118 p=.889	Gender Age	-.023 .144
2	Receptive vocabulary	.255	.250	F(1,46)=15.409 p =.000	Receptive vocabulary	.226
i						
3	RAN skills	.628	.373	F(4,42)=10.543 p =.000	Picture naming Character naming Pinyin letter naming Digit naming	.084 - .276 .106 -.305
4	MA skills	.640	.012	F(4,38)=.315 p =.866	Homophone discrimination Homograph production Homograph discrimination Homophone production	.023 .105 -.119 .054
5	PA skills	.795	.154	F(8,30)=2.819 p =.019	Final sound identification Rhyme production Tone identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	-.007 -.221 .443 .242 .347 -.137 .219 - .311
ii						
3	RAN skills	.628	.373	F(4,42)=10.543 p =.000		
4	PA skills	.788	.160	F(8,34)=3.212 p =.008		
5	MA skills	.795	.006	F(4,30) =.231 p=.919		
iii						
3	PA skills	.675	.421	F(8,38)=6.158 p=.000		
4	MA skills	.703	.027	F(4,34)=.781 p =.545		
5	RAN skills	.795	.092	F(4,30)=3.349 p =.022		

Table 3.25 presents the results from the regression analyses conducted to determine the unique predictors of concurrent Pinyin reading for Grade 4 children. In this case, phonological awareness explained 22% additional variance in Pinyin reading at grade 4 beyond the contributions of morphological awareness and other relevant variables. Whereas, morphological awareness explained 4.2% of unique variability in Pinyin reading beyond the contributions of morphological awareness and the other control variables. And RAN explained 6.8 % additional variance in Pinyin reading at grade 4 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

As in the previous analyses, phonological awareness made the greatest concurrent contribution to Pinyin reading, with rapid naming second and morphological awareness as the third contributor to Pinyin reading in Grade 4.

Table 3.25. Hierarchical Linear Regressions Predicting Concurrent Grade 4 Pinyin Reading

	variables	R^2	R^2 change	Sig R^2change	Final Beta	
1	Gender & Age	.085	.085	F(2,47)=2.178 p=.125	Gender Age	-.098 .348
2	Receptive vocabulary	.091	.006	F(1,46)=.293 p =.591	Receptive vocabulary	-.175
i						
3	RAN skills	.198	.108	F(4,42)=1.411 p =.247	Picture naming Character naming Pinyin letter naming Digit naming	.037 .178 -.302 -.059
4	MA skills	.271	.073	F(4,38)=.950 p =.446	Homophone discrimination Homograph production Homograph discrimination Homophone production	-.256 .183 -.076 .152
5	PA skills	.491	.220	F(8,30)=1.620 p =.161	Final sound identification Rhyme production Ton identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	.113 -.068 .367 -.014 .361 .116 .088 .041
ii						
3	RAN skills	.198	.108	F(4,42)=1.411 p =.247		
4	PA skills	.449	.251	F(8,34)=1.937 p =.086		
5	MA skills	.491	.042	F(4,30) =.615 p=.655		
iii						
3	PA skills	.386	.296	F(8,38)=2.287 p=.042		
4	MA skills	.423	.036	F(4,34)=.537 p =.709		
5	RAN skills	.491	.068	F(4,30)=1.009 p =.419		

Chapter 4

Study 2

Phase 2: cross-sectional data from grades 2, 3and 5

Overview

The major purpose of this study was to discover the developmental patterns of the relationship among cognitive variables and reading ability over a one-year period. Specifically, the relative contributions of three primary cognitive skills (phonological awareness, morphological awareness, and rapid naming) to Chinese reading were explored. To achieve this goal, children's component skills and reading ability were measured again one year after the data collection phase that was reported in Study 1.

Another purpose of the present study was to examine the roles of cognitive factors for text reading comprehension. Reading comprehension is considered central component and the end goal of reading. As in Chinese literacy, most research has identified the contributions of cognitive skills to character reading (e.g., Ho et al. 2002; McBride-Chang et al. 2008; Shu et al. 2008), whereas fewer studies have included the most important skill of text reading. Text reading has been neglected and less explored as a key component of reading skill in Chinese literacy development.

To summarize, the present study had two aims: (1) to investigate the changing roles of phonological, morphological awareness, RAN in predicting character reading over a one-year period, and (2) to explore how these cognitive-linguistic constructs contribute to reading comprehension in addition to Chinese character reading.

Method

Participants

One hundred and forty-nine children remained from the previous sample of 150 children when they were tested again one year later. One child who was lost had moved out of the school district.

Procedure

All measures were administered to the children by trained assessors in two separate sessions. Children's phonological awareness, morphological processing skills, rapid naming, and character reading were assessed individually in the first session, while their reading comprehension was measured in small groups during a second session.Children were tested in a quiet room of school during the second semester of academic year 2014.

Measures

The best predictors for phase1 character reading were selected and used as phase 2 measures. In addition, a morphological construction task and a reading comprehension task were added. Therefore, in Phase 2, a total of 9 tasks, including 2 morphological awareness tasks, 3 phonological awareness tasks, 2 rapid naming task and 2 reading tasks were administered to the three groups of participants.

Phonological Awareness

Initial Sound identification, Final (single) Sound identification and Rhyme detection were used to assess children’s phonological awareness. These tasks were the same as those used in study 1. Details of these tasks were described in study 1.

Morphological Awareness

Homograph discrimination

This test was designed to assess children's morphological awareness at the morpheme level. The format of this task was the same as that in Study 1. New items were devised for the three groups in Study 2 to reduce the influence of prior testing. All of the words used in this task were within the children's spoken vocabulary as judged by the children's classroom teachers. Details of task administration can be found in Study 1.

Morphological construction task

Adapted from the task developed by McBride-Chang et al. (2003), this test was designed to evaluate children’s compound morphological (structure) awareness. As suggested by Chen et al. (2009), morphological construction task require children to analyze a spoken word into its consistent morphemes and then to construct novel words by using already known morphemes. In each trial, children were orally presented with a two-sentence scenario and then asked to construct a compound nonword of similar structure for describing the newly presented scenario by using familiar morphemes. For example, one test trial was: When we want to have soft blood vessels, we say we will soften our blood vessels. What should we say if we want to have hard bones?'（当我们想让我们的血管更加柔软，我们说我们将要软化我们的血管，那么如果我们想让我们的骨骼更加坚硬，我们说我们将要对我们的骨骼怎么样？). The correct answer, in this case, was "harden our bones"（硬化我们的骨骼）. The fact that the children were required to create structurally and linguistically valid words was also highlighted in the process. For instance, 'our bones harden'， in this case, would be incorrect answer because it would not express the meaning intended in the original scenario. Two practice trials were given to children before formal testing to ensure that they understood the task demands. If the children gave a wrong answer or had no response to the practice trial, the assessor would give the correct answer and explain how the answer was obtained from the given scenario. Each correct response received one point (max= 15). The Cronbach's alpha coefficient for the current sample was 0.806.

Rapid Automatic Naming (RAN)

Picture naming and Digit naming were used to assess children's naming speed. These tasks were the same as that in Study 1. Details of these tasks were described in Study 1.

Reading Ability

Character Reading

The format of this task was the same as that in Study 1. New items that were grade-appropriate were devised for the three groups in Study 2. Details of task administration can be found in Study 1.

Speeded Reading Comprehension Test

For this task, the format of reading comprehension fluency test developed by Elbeheri, Everatt, Mahfoudhi, Al-Diyar &Taibah (2011) was used as a model. Children's speeded reading comprehension was measured by using a grade-appropriate reading comprehension test that was compiled from several reading comprehension tests available in Mainland China. This task comprised 36 incomplete Chinese Sentences/Short passages with the complexity level increasing throughout the test. Within each sentence/passage, one character or word was removed. The children's task was to read silently each sentence/passage and select one of three choices presented after the sentence/passage that completed it. The missing characters or words might be nouns, verbs, adjectives, conjunctions or adverbs. The children were given 15 minutes to complete as many sentences/passages as possible, with the number correct in this time giving an indication of speeded reading comprehension. Two practice trials were presented before formal testing to ensure that they understood the task demands. If the child gave a wrong answer or had no response to the practice trials, the assessor would give the correct answer and explain how to choose the correct alternative from the three choices. One point was given to each correct answer and the total score of this test was 36 points. The Cronbach's alpha coefficient for the current sample was 0.86. An example of the reading comprehension measure in Chinese with English transcription is presented below.

Chinese:

在音乐课上，武老师教我们中国的传统乐器，我们都____她讲课，在她的课上，我们不仅获取了更多的中国传统音乐的知识，而且我们在学习过程中得到很多的乐趣。

A. 喜欢 B. 讨厌 C. 害怕 (答案 A)

English transcription:

In music class, Teacher Wu taught us how to play Chinese traditional musical instruments, and we all ___ her teaching. In her class, not only we acquired more knowledge of Chinese classic music, but also we got a lot of fun in learning process.

A. enjoyed B. hated. C. feared (answer: A)

Results and Discussion

Descriptive Statistics

Descriptive statistics including the means, standard deviations, minimum and maximum scores on each test for grade 2, 3 and 5 can be found in Tables 4.1 and 4.2. Generally, it was found that the performance improved across grade levels.

Performances by the older cohort were faster on RAN tasks and better on all other measures than that of their younger counterparts. Across groups, there was adequate variability on all measures.

Table 4.1. Descriptive Statistics of PA and RAN measures for Grades 2, 3 and 5

grade		Initial Sound Detection Phase 2	Final Sound Detection Phase 2	Rhyme Detection Phase 2	Digit Naming Phase 2	Picture Naming Phase 2
2.00	Mean	10.60	8.02	8.70	23.26	29.84
	SD	2.89	2.48	3.32	4.77	6.50
	Min	3.00	2.00	1.00	14.00	19.00
	Max	15.00	13.00	14.00	35.00	49.00
3.00	Mean	12.06	9.06	10.18	22.27	26.92
	SD	2.30	2.63	3.01	5.77	5.69
	Min	6.00	5.00	2.00	15.00	18.00
	Max	15.00	14.00	15.00	41.00	41.00
5.00	Mean	12.26	10.42	10.68	16.36	22.40
	SD	2.88	2.87	3.00	3.10	4.14
	Min	4.00	1.00	2.00	10.00	16.00
	Max	15.00	15.00	15.00	24.00	33.00

Table 4.2. Descriptive Statistics of MA and Reading measures for Grades 2, 3 and 5

grade		Homograph Discrimination Phase 2	Morphological Construction Phase 2	Character Reading Phase 2	Reading Comprehension Phase 2
2.00	Mean	6.86	10.42	18.44	20.68
	SD	2.32	3.19	11.59	5.36
	Min	2.00	4.00	1.00	10.00
	Max	12.00	15.00	64.00	30.00
3.00	Mean	8.33	12.51	47.20	25.80
	SD	2.64	2.55	25.94	4.89
	Min	3.00	6.00	4.00	10.00
	Max	14.00	15.00	109.00	33.00
5.00	Mean	10.44	13.58	79.72	28.84
	SD	2.21	1.74	21.39	3.88
	Min	5.00	9.00	38.00	17.00
	Max	15.00	15.00	115.00	34.00

Correlations among measures

Grade2

Bivariate correlations among all measures for Grade 2 are reported in Table 4.3. Overall, the two reading measures of Character Reading and Reading Comprehension were highly correlated ($r = .665$). The three phonological awareness measures (Initial sound identification, Final sound identification and Rhyme identification) were highly correlated. (rs = .468 to .711). The two rapid naming measures (RAN Pictures and RAN Digits) were highly correlated (r = .625). The two morphological awareness tasks (Homograph discrimination and Morphological Construction) showed a significant correlation (r = .308). These results indicated that these tasks mostly tapped on the aspects within each underlying construct skill.

Examining the correlations between the two reading measures and the other measures administered to Grade 2 participants, Character Reading correlated significantly with most cognitive-linguistic processing measures, with the exception of Digit Naming (r = -0.228). Character Reading was moderately to strongly associated with PA measures (rs =. 441 to .662), MA measures (for homograph discrimination, r = .397; for morphological construction, r = .683), and moderately correlated with picture naming (r = -.323). Character Reading and Reading Comprehension were also significantly inter-related (r = .665). Reading comprehension, in turn, correlated significantly with all the cognitive-linguistic processing measures. Reading comprehension was significantly associated with the PA measures (rs = .429 to .711), the MA measures (for homograph discrimination, r = .567; for morphological construction, r = .635), and moderately correlated with RAN tasks (for digit naming, r=-.384; for picture naming, r = -.413).

Table 4.3. Correlation among all measures for Grade 2 children during phase 2

	Variables	A	B	C	D	E	F	G	H
A	Initial sound Identification								
B	Final sound identification	.468**							
C	Rhyme identification	.711**	.540**						
D	Homograph Discrimination	.441**	.079	.512**					
E	Morphological Construction	.546**	.566**	.744**	.308*				
F	Digit Naming	-.460**	-.510**	-.545**	-.205	-.508**			
G	Picture Naming	-.455**	-.248	-.527**	-.311*	-.434**	.625**		
H	Character Reading	.467**	.441**	.662**	.397**	.683**	-.228	-.323*	
I	Reading Comprehension	.677**	.429**	.711**	.567**	.635**	-.384**	-.413**	.665**

**. $p< 0.01$. *. $p< 0.05$.

Grade3

Table 4.4 presents inter-correlations among all measures for Grade 3 children. In general, the two reading measures, Character Reading and Reading Comprehension, were highly correlated (r = .799). The three phonological awareness measures (Initial sound identification, Final sound identification and Rhyme identification) were also highly correlated (rs = .504 to .683). The two rapid naming measures (RAN Pictures and RAN Digits) were highly correlated (r= .655). And, finally, the two morphological awareness tasks (Homograph discrimination and Morphological Construction) were significantly correlated (r = .578). These results indicated that these tasks mostly tapped on the aspects within each underlying construct skill.

Examining the correlations between two reading measures and all other measures administered to Grade 3 participants, Character Reading correlated significantly with most measures, with the exception of final sound identification (r = 0.253). Character Reading was significantly associated with two PA measures (for initial sound identification, r = .576; for rhyme identification, r = .516) , strongly associated with two MA measures (for homograph discrimination r = .656; for morphological construction r = .629), and moderately correlated with RAN tasks (for picture naming r = -.294; for digit naming, r = -.465). The correlation between Character Reading and Reading Comprehension was also significant (r = .799). Reading comprehension, in turn, correlated significantly with all the cognitive-linguistic processing measures. Reading comprehension was significantly to strongly associated with PA measures (rs

= .355 to .584), MA measures (for homograph discrimination, $r = .656$; for morphological construction, $r = .605$), and strongly correlated with RAN tasks (for digit naming, $r = -.640$; for picture naming, $r = -.404$).

Table 4.4. Correlation among all measures for Grade 3 children during phase 2

	Variables	A	B	C	D	E	F	G	H
A	Initial Sound Detection								
B	Final Sound Detection	.554**							
C	Rhyme Detection	.683**	.504**						
D	Homograph Discrimination	.520**	.340*	.445**					
E	Morphological Construction	.395**	.179	.272	.578**				
F	Digit Naming time	-.393**	-.254	-.303*	-.401**	-.351*			
G	Picture Naming time	-.383**	-.435**	-.273	-.400**	-.234	.655**		
H	Character Reading	.576**	.253	.516**	.656**	.629**	-.465**	-.294*	
I	Reading Comprehension	.584**	.355*	.460**	.656**	.605**	-.640**	-.404**	.799**

**. $p < 0.01$. *. $p < 0.05$.

Grade 5

Table 4.5 presents the inter-correlations among the measures administered to Grade 5 participants. In general, the two reading measures, Character Reading and Reading Comprehension, were highly correlated (r = .729). The three phonological awareness measures (Initial sound identification, Final sound identification and Rhyme identification) were highly correlated (rs = .494 to .548). The two rapid naming measures (RAN Pictures and RAN Digits) were correlated (r = .444). And, the two MA tasks (Homograph discrimination and Morphological Construction) were correlated (r = .473). Again, the results indicated that these tasks mostly tapped on the aspects within each underlying construct skill.

Examining the correlations between two reading measures and all other measures administered to Grade 5 participants, Character Reading correlated significantly with all measures. Overall, Character Reading was significantly associated with the three PA measures (for initial sound identification, r = 389; for final sound identification, r = .347; for rhyme identification, r = . 550), was strongly associated with the two MA measures (for homograph discrimination, r = .655; for morphological construction, r = .481), and was significantly correlated with RAN tasks (for picture naming, r = -.470; for digit naming, r = -.515). Reading comprehension, in turn, correlated significantly with all the cognitive processing measures. Overall, Reading comprehension was moderately associated with the PA measures (rs = .317 to .410), the MA measures (for homograph discrimination, r = .464; for morphological construction, r = .431), and the RAN tasks (for digit naming, r = -.465; for picture naming r = -.542). The correlation between Character Reading and Reading Comprehension was also significant (r = .729).

Table 4.5. Correlation among all measures for Grade 5 children during phase 2

	Variables	A	B	C	D	E	F	G	H
A	Initial Sound Identification								
B	Final Sound identification	.519**							
C	Rhyme Identification	.548**	.494**						
D	Homograph Discrimination	.209	.368**	.415**					
E	Morphological Construction	.384**	.228	.420**	.473**				
F	Digit Naming	-.239	-.169	-.251	-.479**	-0.18			
G	Picture Naming	-.151	-.044	-.218	-.258	-.325*	.444**		
H	Character Reading	.389**	.347*	.550**	.655**	.481**	-.515**	-.470**	
I	Reading Comprehension	.410**	.317*	.363**	.464**	.431**	-.465**	-.542**	.729**

**. $p< 0.01$. *. $p< 0.05$.

Unique Predictors of Time2 Character Reading and Reading Comprehension

The predictor variables of interest in study 2 were related to 7 tasks, which fell into the three constructs: phonological awareness (PA), morphological awareness (MA) and RAN. To examine the unique contributions of the two awareness variables to Chinese character reading and reading comprehension respectively, hierarchical regression analyses were performed with Chinese Character Reading as the measure to be predicted in the first run, while the same analyses were performed with Chinese Reading Comprehension as dependent variable in the second run. In each, age and gender, then receptive vocabulary, then rapid naming were entered in steps 1 to 3. The two awareness variables were then entered as the last two steps in each of the regression models to examine their unique contributions to Chinese character reading and Reading Comprehension respectively. Results from these regressions were presented in Tables 4.6 to 4.11.

Character Reading

The regression results for Grade 2 Chinese Character Reading were presented in Table 4.6. When entered as the last step, phonological explained 5.2% additional variance in Chinese character reading at grade 2 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained 8.1% of unique variability in Chinese character reading beyond the contributions of phonological awareness and the other control variables.

To investigate the role of RAN in grade 2 character reading, a further hierarchical regression analysis was run with the RAN measures entered as the last step. As shown in Table 4.6(iii), when entered as the last step, RAN explained 2.6% additional variance in Chinese character reading at grade 2 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

Based on the above regression models, the result indicated that morphological awareness made the greatest significant contribution to Chinese character reading, while phonological awareness was the second contributor .

Table 4.6. Hierarchical Linear Regressions Predicting Concurrent Grade 2 Character Reading at Time 2

	Variables	R^2	R^2 change	Sig R^2change	Final Beta	
1	Gender& Age	.053	.053	F(2,47)=1.310 p =.279	Gender Age	.100 .189
2	Receptive vocabulary	.153	.100	F(1,46)=5.432 p =.024	Receptive vocabulary	.075
i						
3	RAN skills	.198	.045	F(2,44)=1.244 p=.298	Picture naming Digit naming	-.017 .226
4	MA skills	.593	.395	F(2,42)=20.353 p=.000	Homograph discrimination Morphological construction	.155 .425
5	PA skills	.645	.052	F(3,39) =1.911 p =.144	Final sound identification Initial sound identification Rhyme identification	.142 -.071 .350
ii						
3	RAN skills	.198	.045	F(2,44)=1.244 p =.298		
4	PA skills	.564	.366	F(3,41)=11.469 p =.000		
5	MA skills	.645	.081	F(2,39)=4.447 p =.018		
iii						
3	PA skills	.54	.387	F(3.43)=12.070 p =.000		
4	MA skills	.619	.078	F(2,41)=4.215 p =.022		
5	RAN skills	.645	.026	F(2,39)=1.453 p =.246		

The regression results for Grade 3 Chinese Character Reading were presented in Table 4.7. When entered as the last step, phonological explained 5.7% additional variance in Chinese character reading at grade 3 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained 14.7% of unique variability in Chinese character reading beyond the contributions of phonological awareness and the other control variables. RAN, when entered as the last step, explained 2.3% additional variance in Chinese character reading at grade 3 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

Overall, the results indicated that morphological awareness made the greatest significant contribution to Chinese character reading, while phonological awareness did not play a significant role in character reading in this group.

Table 4.7. Hierarchical Linear Regressions Predicting Concurrent Grade 3 Character Reading at Time2

	variables	R^2	R^2 change	Sig R^2change	Final Beta	
1	Gender& Age	.001	.001	F(2,46)=.016 p= .984	Gender Age	-.051 .015
2	Receptive vocabulary	.205	.204	F(1,45)=11.539 p=.001	Receptive vocabulary	.133
i						
3	RAN skills	.351	.146	F(2,43)=4.854 p =.013	Picture naming Digit naming	.127 -.214
4	MA skills	.588	.237	F(2,41)=11.785 p=.000	Homograph discrimination Morphological construction	.288 .270
5	PA skills	.645	.057	F(3,38)=2.028 p =.126	Final sound identification Initial sound identification Rhyme identification	-.126 .180 .185
ii						
3	RANskills	.351	.146	F(2,43)=4.854 p =.013		
4	PA skills	.498	.146	F(3,40)=3.886 p =.016		
5	MA skills	.645	.147	F(2,38)=7.879 p =.001		
iii						
3	PA skills	.437	.233	F(3.42)=5.794 p =.002		
4	MA skills	.622	.185	F(2,40)=9.791 p =.000		
5	RANskills	.645	.023	F(2,38)=1.204 p =.311		

The regression results for Grade 5 Chinese Character Reading were presented in Table 4.8. When entered as the last step, phonological awareness explained 1.4% additional variance in Chinese character reading at grade 5 beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained 12% of unique variability in Chinese character reading beyond the contributions of phonological awareness and the other control variables. And, when entered as the last step, RAN explained 5.4% additional variance in Chinese character reading at grade 5 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

These result indicated that morphological awareness made the greatest significant contribution to Chinese character reading and phonological awareness did not, while RAN also play a significant role in character reading in this group.

Table 4.8. Hierarchical Linear Regressions Predicting Concurrent Grade 5 Character Reading at Time2

	variables	R^2	R^2 change	**Sig** R^2**change**	**Final Beta**	
1	Gender& Age	.051	.051	F(2,47)=1.270 p=.290	Gender Age	-.015 .118
2	Receptive vocabulary	.252	.201	F(1,46)=12.375 p=.001	Receptive vocabulary	.243
i						
3	RAN skills	.477	.224	F(2,44)=9.418 p =.000	Picture naming Digit naming	-.139 -.178
4	MA skills	.664	.187	F(2,42)=11.690 p=.000	Homograph discrimination Morphological construction	.363 .153
5	PA skills	.677	.014	F(3,39)=.549 p=.652	Final sound identification Initial sound identification Rhyme identification	-.025 .082 .103
ii						
3	RAN skills	.477	.224	F(2,44)=9.418 p =.000		
4	PA skills	.557	.081	F(3,41)=2.496 p =.073		
5	MA skills	.677	.120	F(2,39)=7.251 p =.002		
iii						
3	PA skills	.398	.146	F(3.43)=3.475 p =.024		
4	MA skills	.623	.225	F(2,41)=12.231 p=.000		
5	RAN skills	.677	.054	F(2,39)=3.275 p =.048		

Reading Comprehension

To examine the relative contributions of phonological awareness, morphological awareness and RAN to concurrent reading comprehension, hierarchical regressions were performed in the same way as for Chinese character reading. Results from these regression analyses were summarized in Tables 4.9 to 4.11.

The regression results for Grade 2 Reading Comprehension were presented in Table 4.9. When entered as the last step, phonological explained 8.4% additional variance in reading comprehension beyond the contributions of morphological awareness and other relevant variables. In contrast, morphological awareness explained 6.3% of unique variability in reading comprehension beyond the contributions of phonological awareness and the other control variables. And, when entered as the last step, RAN explained less than 1% additional variance in reading comprehension beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

These result indicated that phonological awareness made the greatest significant contribution to Chinese reading comprehension, with morphological awareness also play a significant role in Grade 2 reading comprehension.

Table 4.9. Hierarchical Linear Regressions Predicting Concurrent Grade 2 Reading Comprehension at Time2

	variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender& Age	.012	.012	F(2,47)=.292 p= .748	Gender Age	.017 -.050
2	Receptive vocabulary	.141	.128	F(1,46)=6.867 p=.012	Receptive vocabulary	.080
i						
3	RAN skills	.221	.080	F(2,44)=2.270 p=.115	Picture naming Digit naming	.021 .080
4	MA skills	.565	.344	F(2,42)=16.591 p=.000	Homograph discrimination Morphological construction	.266 .242
5	PA skills	.649	.084	F(3,39)=3.104 p=.038	Final sound identification Initial sound identification Rhyme identification	.069 .286 .180
ii						
3	RAN skills	.221	.080	F(2,44)=2.270 p=.115		
4	PA skills	.586	.365	F(3,41)=12.052 p=.000		
5	MA skills	.649	.063	F(2,39)=3.477 p=.041		
iii						
3	PA skills	.580	.439	F(3.43)=14.978 p=.000		
4	MA skills	.644	.064	F(2,41)=3.706 p=.033		
5	RAN skills	.649	.005	F(2,39)=.255 p =.776		

The regression results for Grade 3 Reading Comprehension were presented in Table 4.10. When entered as the last step, phonological explained 3.5% additional variance in reading comprehension at grade 3 beyond the contributions of morphological awareness and other relevant variables. Morphological awareness explained 12.2% of unique variability in reading comprehension beyond the contributions of phonological awareness and the other control variables. The RAN measures explained 10.6% additional variance in reading comprehension at grade 3 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

The results indicated that morphological awareness made the greatest significant contribution to Grade 3 Chinese reading comprehension and phonological awareness did not, while RAN also make a great significant contribution to Grade 3 reading comprehension.

Table 4.10. Hierarchical Linear Regressions Predicting Concurrent Grade 3 Reading Comprehension at Time2

	Steps& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender& Age	.017	.017	F(2,46)=.399 p= .673	Gender Age	-.045 -.100
2	Receptive vocabulary	.169	.152	F(1,45)=8.203 p=.006	Receptive vocabulary	.040
i						
3	RAN skills	.484	.316	F(2,43)=13.168 p=.000	Picture naming Digit naming	.170 -.446
4	MA skills	.671	.186	F(2,41)=11.607 p=.000	Homograph discrimination Morphological construction	.269 .238
5	PA skills	.706	.035	F(3,38)=1.496 p =.231	Final sound identification Initial sound identification Rhyme identification	.055 .192 .016
ii						
3	RAN skills	.484	.316	F(2,43)=13.168 p=.000		
4	PA skills	.584	.099	F(3,40)=3.186 p =.034		
5	MA skills	.706	.122	F(2,38)=7.855 p =.001		
iii						
3	PA skills	.403	.234	F(3.42)=5.493 p =.003		
4	MA skills	.600	.197	F(2,40)=9.846 p =.000		
5	RAN skills	.706	.106	F(2,38)=6.821 p =.003		

The regression results for Grade 5 Reading Comprehension were presented in Table 4.11. When entered as the last step, phonological explained 5% additional variance in reading comprehension at grade 4 beyond the contributions of morphological awareness and other relevant variables. Morphological awareness explained 7.9% of unique variability in reading comprehension beyond the contributions of phonological awareness and the other control variables. The RAN measures explained 11.4% additional variance in reading comprehension at grade 5 beyond the contributions of morphological awareness, phonological awareness and other relevant variables.

The results indicated that RAN made the greatest significant contribution to Grade 5 Chinese reading comprehension and morphological awareness also make a significant contribution, while phonological awareness did not play a significant role in Grade 5 reading comprehension.

Overall, the findings of longitudinal data indicate a change in relationships across grades such that early Chinese-language phonological predictors of Chinese character and text reading are replaced by morphological processing skills and measures of rapid naming.

Table 4.11. Hierarchical Linear Regressions Predicting Concurrent Grade 5 Reading Comprehension at Time2

	variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender& Age	.047	.047	F(2,47) =1.150 p=.325	Gender Age	.084 .234
2	Receptive vocabulary	.208	.161	F(1,46)=9.374 p =.004	Receptive vocabulary	.248
i						
3	RAN skills	.458	.249	F(2,44)=10.117 p=.000	Picture naming Digit naming	-.264 -.192
4	MA skills	.542	.084	F(2,42)=3.870 p =.029	Homograph discrimination Morphological construction	.177 .251
5	PA skills	.592	.050	F(3,38)=1.606 p =.204	Final sound identification Initial sound identification Rhyme identification	.112 .229 -.247
ii						
3	RAN skills	.458	.249	F(2,44)=10.117 p=.000		
4	PA skills	.514	.056	F(3,41)=1.580 p=.209		
5	MA skills	.592	.079	F(2,39)=3.757 p=.032		
iii						
3	PA skills	.299	.091	F(3.43)=1.854 p=.152		
4	MA skills	.478	.179	F(2,41)=7.033 p=.002		
5	RAN skills	.592	.114	F(2,39)=5.472 p=.008		

Chapter 5

Study 3

Longitudinal analyses between Phase 1 and Phase 2

Overview

In the present study, the data from phases 1 and 2 were analyzed in order to investigate whether early phonological awareness, morphological awareness, and rapid naming could predict literacy in Chinese one year later.

One research question was addressed in the present study. Do the three primary cognitive-linguistic skills (phonological awareness, morphological awareness, and rapid naming) measured at an earlier time predict reading at a later time? To examine this question, hierarchical regression analyses were conducted with time 1 measures as predictor variables and time 2 outcomes as the measures to be predicted. The results were reported in the following sections.

Correlations between reading measures at time 2 and cognitive-linguistic skills at time 1

Table 5.1 presents the correlations between Time 2 reading measures (character reading and reading comprehension) and all the measures at Time1 for Grade 1 children at time 1 who were Grade 2 children at time 2. Overall, character reading at Time 2 was significantly correlated with most phonological tasks at Time 1 (rs = .314 to .497), with the exceptions of Syllable deletion (r = .157) and Rhyme production (r

=.257). Character reading at Time 2 was also significantly correlated with two morphology measures: homophone production (r= .423) and homograph production (r = .336). Character reading at Time 2 was also significantly associated with one RAN task: Picture Naming (r = -.332).

Character reading at Time 2 was significantly correlated with Time 1 Nonword Reading (r=.728) and receptive vocabulary at Time 1 (r=.341). Time 1 Pinyin Reading was moderately associated with Time 2 character reading (r=.337) and Character reading across the two time points was highly correlated (r=.711).

Reading comprehension at Time 2, in turn, was significantly or highly correlated with most phonological tasks at Time 1 (rs =.320 to .639), with the exception of Rhyme production (r =.182). Reading comprehension at Time 2 was strongly correlated with all the MA measures (rs = .388 to .538), and significantly or strongly associated with the RAN tasks (for digit naming, r= -.391; for character naming, r = -.350; for picture naming, r=-.453). Both Time 1 Pinyin Reading and Nonsyllable reading were strongly associated with Time 2 reading comprehension (for Pinyin Reading, r=.582; for Nonsyllable reading, r=.404). And the relation between receptive vocabulary and reading comprehension was significant (r=.341). Finally, Time 2 reading comprehension was highly associated with Time 1 character reading (r= .731) and Nonword reading (r = .745).

Table 5.1. Correlations between reading measures at Time 2 and various skills at Time 1 for children moving from Grade 1 to Grade 2

	Character Reading T2	Reading Comprhension T2
Syllable Deletion	.157	.390**
Syllable Identification	.464**	.598**
Initial Sound Identification	.390**	.639**
Initial Sound Deletion	.497**	.596**
Final Sound Identification	.314*	.320*
Final Sound Deletion	.315*	.343*
Rhyme Identification	.367**	.445**
Rhyme Production	.257	.182
Tone Identification	.467**	.534**
Homophone Discrimination	.126	.388**
Homograph Discrimination	.233	.494**
Homophone Production	.423**	.538**
Homograph Production	.336*	.463**
Digit Naming	-.237	-.391**
Pinyin Letter Naming	-.275	-.206
Character Naming	-.267	-.350*
Picture Naming	-.332*	-.453**
Nonword Reading	.728**	.745**
Nonsyllable Reading	.230	.404**
Receptive Vocabulary	.341*	.341*
Character Reading	.711**	.731**
Pinyin Reading	.337*	.582**

**. p< 0.01.   *. p< 0.05 .

Table 5.2 presents the correlations between Time 2 reading measures and the measures at Time 1 for Grade 2 children who moved to Grade 3 at Time 2. Overall, character reading at Time 2 was significantly correlated with most phonological tasks at Time 1 (rs = .326 to .546), with the exceptions of final sound identification and final sound deletion. Character reading at Time 2 was also significantly correlated with one MA measures, homophone discrimination (r=.425). It was also highly associated with all the RAN tasks at Time 1 (rs = -.446 to -.593).

Within Time 1 and Time 2 reading measures, Character reading at Time 2 correlated highly with Time 1 Nonword Reading (r =.668), Time1 Pinyin reading (r = .472) and Nonsyllable reading (r=.433). Time1 and Time 2 character reading were highly correlated (r =.714). Additionally, the relation between receptive vocabulary Time 1 and character reading Time 2 was significant (r =.440).

Reading comprehension at Time 2, in turn, was significantly or highly correlated with most phonological tasks at Time 1 (rs =.285 to .586), with the exception of final sound identification. It was also significantly associated with two MA tasks: Homophone discrimination (r = .431), Homograph discrimination (r = .321). Reading comprehension at Time 2 was also strongly correlated with all the RAN measure (rs = -.370 to -.650).

Across the Time 1 and Time 2 reading measures, both Time1 Pinyin Reading and Nonsyllable reading were strongly associated with Time 2 reading comprehension (for Pinyin Reading, r=.547; for Nonsyllable reading, r=.500). Time 2 reading comprehension was also highly associated with Time 1 character reading (r=.639) and Nonword reading (r=.666). Furthermore, the relationship between receptive vocabulary and reading comprehension was significant (r =.410).

Table 5.2. Correlations between reading measures at Time 2 and various skills at Time 1 for children moving from Grade 2 to Grade 3

	Character Reading T2	Reading ComprhensionT2
Syllable Deletion T1	.[a]	.[a]
Syllable Identification T1	.326*	.426**
Initial Sound Identification	.529**	.586**
Initial Sound Deletion T1	.456**	.435**
Final Sound Identification T1	.082	.239
Final Sound Deletion T1	.148	.285*
Rhyme Identification T1	.546**	.522**
Rhyme Production T1	.436**	.404**
Tone Identification T1	.370**	.418**
Homophone Discrimination T1	.425**	.431**
Homograph Discrimination T1	.113	.321*
Homophone Production T1	-.009	.108
Homograph Production T1	.118	.229
Digit Naming T1	-.593**	-.650**
Pinyin Letter Naming T1	-.472**	-.485**
Character Naming T1	-.446**	-.525**
Picture Naming T1	-.447**	-.370**
Nonword Reading T1	.668**	.666**
Nonsyllable Reading T1	.433**	.500**
Receptive Vocabulary T1	.440**	.410**
Character Reading T1	.714**	.639**
Pinyin Reading T1	.472**	.547**

**. $p< 0.01$. *. $p< 0.05$. [a] *indicates no variability in the syllable deletion task*

Table 5.3 presents the correlations between Time 2 reading measures and the measures at Time1 for Grade 4 children who moved to Grade 5 in phase 2. Overall, character reading at Time 2 correlated significantly with four Time 1 phonological measures (for final sound deletion, r=.331; rhyme identification, r=.417; rhyme production, r=.313; tone identification, r=.314), with three Time 1 morphology measures (for homophone discrimination, r=.517; homograph discrimination, r=.504; homophone production, r=.335), and with two Time 1 RAN tasks (for Character naming, r = -.354; Picture Naming, r = -.439).

Across Time 1 and Time 2 reading measures, Character reading at Time 2 correlated highly with Time 1 Nonword Reading (r =.762). Time 1 Nonsyllable Reading was strongly associated with Time 2 character reading (r =.498). The relationship between Pinyin reading at Time 1 and character reading at Time 2, however, was not significant (r =.267). Time 1 and Time 2 character reading was highly correlated (r =.844). Additionally, the relation between receptive vocabulary at Time 1 and character reading at Time 2 was significant (r =.460).

Reading comprehension at Time 2, in turn, was significantly correlated with Rhyme production (r =.335), homograph discrimination (r =.370) and picture naming (r = -.548) at Time 1. Time1 Nonsyllable Reading was moderately associated with Time 2 reading comprehension (r =.364). The relationship between Pinyin reading at Time 1 and reading comprehension at Time 2, however, was not significant (r =.073). Time 2 reading comprehension was significantly associated with both Time 1 character reading ($r=.494$) and Nonword reading ($r=.476$). The relation between receptive vocabulary at Time 1 and reading comprehension at Time 2 was significant ($r=.415$).

Table 5.3. Correlations between reading measures at time 2and various skills at Time 1 for children moving from Grade 4 to Grade 5

	Character Reading T2	Reading Comprehension T2
Syllable Deletion T1	.[a]	.[a]
Syllable Identification T1	.263	.233
Initial Sound Identification T1	.247	.172
Initial Sound Deletion T1	.204	.149
Final Sound Identification T1	.190	.224
Final Sound Deletion T1	.331*	.160
Rhyme Identification T1	.417**	.109
Rhyme Production T1	.313*	.335*
Tone Identification T1	.314*	.126
Homophone Discrimination T1	.517**	.229
Homograph Discrimination T1	.504**	.370**
Homophone Production T1	.335*	.222
Homograph Production T1	.278	-.120
Digit Naming T1	-.267	-.226
Pinyin Letter Naming T1	-.107	-.087
Character Naming T1	-.354*	-.237
Picture Naming T1	-.439**	-.548**
Nonword Reading T1	.762**	.476**
Nonsyllable Reading T1	.498**	.364**
Receptive Vocabulary T1	.460**	.415**
Character Reading T1	.844**	.494**
Pinyin Reading T1	.267	.073

**. $p< 0.01$. *. $p< 0.05$. [a] *indicates no variability in the syllable deletion task*

Longitudinally predicting character reading and reading comprehension

Similar to Study 1, the predictor variables obtained at Time 1, which fell into the three constructs (phonological awareness (PA), morphological awareness (MA) and RAN), were used to examine the longitudinal unique contributions to subsequent, Time 2, Chinese character reading and reading comprehension.

Hierarchical regression analyses were performed with Chinese Character Reading (Time 2) and Chinese Reading Comprehension (Time 2) as dependent variables. In each set of analyses, age and gender, then receptive vocabulary, then rapid naming (Time1) were entered in steps 1 to 3. The two awareness variables obtained at Time 1 were then entered as the last two steps in each of the regression models to examine their longitudinal unique contributions to subsequent Chinese character reading and Reading Comprehension respectively. Results from the longitudinal analyses were summarized in Tables4to9.

Character Reading

The results of longitudinal regression analyses predicting Time 2 Chinese Character Reading for Grade 1 moving to Grade 2 children were presented in Table 5.4. As indicated in the table, when entered as the last step, phonological awareness measured at Time 1 explained 19.6% additional variance in Time 2 Chinese character reading beyond the contributions of morphological awareness and other relevant variables. In contrast, Time 1 morphological awareness explained 7.2% of unique variability in Time 2 Chinese character reading beyond the contributions of phonological awareness and the other control variables. When Time 1 RAN measures were entered as the last step, an additional 1% of variance in Time 2 Chinese character reading was explained beyond the effects of morphological awareness, phonological awareness and the other relevant variables.

In the above longitudinal regression models, the variables which made longitudinal contributions to subsequent Chinese character reading across the two first grades were identified. The results indicated that earlier phonological awareness made the greatest contribution to Chinese character reading measured one year later, while morphological awareness was the second.

Table 5.4. Longitudinal Hierarchical Linear Regression Predicting Time 2 Chinese Character Reading for Grade 1 children moving to Grade 2

	Step& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.053	.053	F(2,47)=1.310 p=.279	Gender Age	.088 .266
2	Receptive vocabulary	.153	.100	F(1,46)=5.432 p=.024	Receptive vocabulary	.161
i						
3	RAN skills	.256	.103	F(4,42)=1.457 p=.232	Picture naming Character naming Pinyin letter naming Digit naming	-.121 -.011 .148 .017
4	MA skills	.344	.088	F(4,38)=1.275 p=.297	Homograph production Homophone discrimination Homograph discrimination Homophone production	-.152 .038 .288 .311
5	PA skills	.540	.196	F(9,29)=1.371 p=.246	Rhyme production Syllable deletion Final sound deletion Tone identification Final sound identification Initial sound deletion Initial sound identification Rhyme identification Syllable identification	.190 -.312 .033 .004 .010 .455 -.587 .245 .359
ii						
3	RAN skills	.256	.103	F(4,42)=1.457 p=.232		
4	PA skills	.468	.212	F(9,33)=1.463 p=.203		
5	MA skills	.540	.072	F(4,29)=1.130 p=.362		
iii						
3	PA skills	.451	.298	F(9.37)=2.229 p=.042		
4	MA skills	.530	.079	F(4,33)=1.390 p=.259		
5	RAN skills	.540	.010	F(4,29)=.158 p=.958		

The results of longitudinal regression analyses predicting Time 2 Chinese Character Reading for Grade 2 children moving to Grade 3 were presented in Table 5.5. As indicated, when entered as the last step, the phonological awareness measures at Time 1 explained an additional 15.9% of variance in Time 2 Chinese character reading beyond the contributions of morphological awareness and other relevant variables. Time 1 morphological awareness explained 10% of unique variability in Time 2 Chinese character reading beyond the contributions of phonological awareness and the other control variables. And Time 1 RAN measures, when entered as the last step, explained 1.8% additional variance in Time 2 Chinese character reading beyond the effects of morphological awareness, phonological awareness and other relevant variables.

In the above longitudinal regression models, the results indicated that earlier phonological awareness and morphological awareness accounted for a unique portion of variance respectively in Chinese character reading measured one year later.

Table 5.5. Longitudinal Hierarchical Linear Regression Predicting Time 2 Chinese Character Reading for Grade 2 children moving to Grade 3

	Step& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.001	.001	F(2,46)=.016 p=.984	Gender Age	-.070 .072
2	Receptive vocabulary	.205	.204	F(1,45)=11.539 p=.001	Receptive vocabulary	.173
i						
3	RAN skills	.448	.243	F(4,41)=4.518 p=.004	Picture naming Character naming Pinyin letter naming Digit naming	-.112 .054 .029 -.212
4	MA skills	.517	.069	F(4,37)=1.331 p=.277	Homophone discrimination Homograph production Homograph discrimination Homophone production	.343 .232 -.035 -.108
5	PA skills	.677	.159	F(8,29)=1.785 p=.121	Final sound identification Rhyme production Tone identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	-.408 .037 .073 -.061 .158 .376 .205 -.272
ii						
3	RAN skills	.448	.243	F(4,41)=4.518 p =.004		
4	PA skills	.577	.129	F(8,33)=1.259 p=.298		
5	MA skills	.677	.100	F(4,29)=2.234 p=.090		
iii						
3	PA skills	.489	.284	F(8,37)=2.567 p=.025		
4	MA skills	.659	.170	F(4,33)=4.122 p=.008		
5	RAN skills	.677	.018	F(4,29)=.397 p=.809		

The results of longitudinal regression analyses predicting Time 2 Chinese Character Reading for Grade 4 children moving to Grade 5 were presented in Table 5.6. As indicated, phonological awareness measured at Time 1 explained 7.1% additional variance in Time 2 Chinese character reading beyond the contributions of morphological awareness and other relevant variables. Time 1 morphological awareness explained 14.3% of unique variability in Time 2 Chinese character reading beyond the contributions of phonological awareness and the other control variables. And Time 1 RAN measures explained additional 7.8% unique variance in Time 2 Chinese character reading beyond the effects of morphological awareness, phonological awareness and other relevant variables.

These longitudinal regression results argued that earlier morphological awareness made the greatest significant contribution to subsequent character reading and RAN was the second contributor. In contrast, phonological awareness account for a least portion of unique variance in subsequent character reading for this cohort of children.

Table 5.6. Longitudinal Hierarchical Linear Regression Predicting Time 2 Chinese Character Reading for Grade 4 Children moving to Grade 5

	variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.051	.051	F(2,47) =1.270 p=.290	Gender Age	.092 .026
2	Receptive vocabulary	.252	.201	F(1,46)=12.375 p=.001	Receptive vocabulary	.304
i						
3	RAN skills	.374	.121	F(4,42) =2.031 p=.107	Picture naming Character naming Pinyin letter naming Digit naming	-.453 -.086 .036 .136
4	MA skills	.586	.213	F(4,38)= 4.883 p=.003	Homophone discrimination Homograph production Homograph discrimination Homophone production	.487 -.150 .284 -.204
5	PA skills	.657	.071	F(8,30)=.776 p=.627	Final sound identification Rhyme production Tone identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	.099 -.020 .153 .165 -.213 -.288 .108 .044
ii						
3	RAN skills	.374	.121	F(4,42) =2.031 p=.107		
4	PA skills	.514	.141	F(8,34) =1.230 p=.312		
5	MA skills	.657	.143	F(4,30) =3.127 p=.029		
iii						
3	PA skills	.441	.188	F(8,38)=1.598 p=.158		
4	MA skills	.579	.139	F(4,34) =2.807 p=.041		
5	RAN skills	.657	.078	F(4,30)=1.700 p=.176		

Reading comprehension

To examine the relative contributions of earlier phonological awareness, morphological awareness and RAN to later reading comprehension assessed one year later, hierarchical regressions were performed in the same way as that for Chinese character reading. Results were summarized in Tables 5.7 to 5.9.

The results of longitudinal regression predicting Time 2 Reading Comprehension for Grade 1 moving to Grade 2 children were presented in Table 5.7. These indicated that phonological awareness measured at Time 1 explained an additional 11.2% of variance in reading comprehension administered at Time 2 beyond the contributions of morphological awareness and other relevant variables. In contrast, Time 1 morphological awareness predicted 6.2% of unique variability in Time 2 reading comprehension beyond the contributions of phonological awareness and the other control variables. Additionally, Time 1 RAN measures accounted for 3.9% unique variance in Time 2 reading comprehension after controlling for the effects of earlier morphological awareness, phonological awareness and other relevant variables.

The results indicated that earlier phonological awareness made the greatest contribution to Chinese reading comprehension measured one year later, while both morphological awareness and RAN also accounted for unique portions of variance in reading comprehension in these young readers.

Table 5.7. Longitudinal Hierarchical Linear Regression Predicting Time2 Reading Comprehension for Grade 1 Children moving to Grade 2

	variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.012	.012	F(2,47)=.292 p=.748	Gender	-.136
					Age	.028
2	Receptive vocabulary	.141	.128	F(1,46)=6.867 p=.012	Receptive vocabulary	.139
i						
3	RAN skills	.318	.178	F(4,42)=2.737 p=.041	Picture naming	-.206
					Character naming	-.115
					Pinyin letter naming	.240
					Digit naming	-.035
4	MA skills	.560	.242	F(4,38)=5.218 p=.002	Homograph production	-.035
					Homophone discrimination	.246
					Homograph discrimination	.142
					Homophone production	.162
5	PA skills	.672	.112	F(9,29)=1.095 p=.397	Rhyme production	-.007
					Syllable deletion	-.156
					Final sound deletion	.197
					Tone identification	.036
					Final sound identification	-.163
					Initial sound deletion	.327
					Initial sound identification	.007
					Rhyme identification	-.001
					Syllable identification	.211
ii						
3	RAN skills	.318	.178	F(4,42)=2.737 p=.041		
4	PA skills	.609	.291	F(9,33)=2.734 p=.017		
5	MA skills	.672	.062	F(4,29)=1.371 p=.268		
iii						
3	PA skills	.544	.403	F(9.37)=3.632 p=.002		
4	MA skills	.632	.088	F(4,33)=1.983 p=.120		
5	RAN skills	.672	.039	F(4,29)=.871 p=.493		

The results of longitudinal regression predicting Time 2 Reading Comprehension for Grade 2 moving to Grade 3 children were presented in Table 5.8. As indicated, phonological awareness measured at Time 1 explained additional 10.7% variance in reading comprehension administered at Time 2 beyond the contributions of morphological awareness and other relevant variables. In contrast, Time 1 morphological awareness predicted 10% of unique variability in Time 2 reading comprehension beyond the contributions of phonological awareness and the other control variables. Time 1 RAN accounted for 2.6% unique variance in Time2 reading comprehension after controlling for the effects of earlier morphological awareness, phonological awareness and other relevant variables.

The results indicated that earlier phonological awareness and morphological awareness made roughly equal contributions to subsequent Chinese reading comprehension at Time 2, while earlier RAN accounted for a small portion of unique variance in reading comprehension for the same cohort of children.

Table 5.8. Longitudinal Hierarchical Linear Regression Predicting Time 2 Chinese Reading Comprehension for Grade 2 Children moving to Grade 3

	Step& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.017	.017	F(2,46)=.399 p=.673	Gender Age	-.022 -.098
2	Receptive vocabulary	.169	.152	F(1,45)=8.203 p=.006	Receptive vocabulary	.047
i						
3	RAN skills	.461	.293	F(4,41)=5.565 p=.001	Picture naming Character naming Pinyin letter naming Digit naming	.004 -.041 -.023 -.225
4	MA skills	.529	.067	F(4,37)=1.323 p=.280	Homophone discrimination Homograph production Homograph discrimination Homophone production	.243 .153 .203 -.056
5	PA skills	.636	.107	F(8,29)=1.063 p=.415	Final sound identification Rhyme production Tone identification Final sound deletion Initial sound deletion Initial sound identification Rhyme identification Syllable identification	-.311 -.147 .076 .052 .075 .452 .184 -.187
ii						
3	RAN skills	.461	.293	F(4,41)=5.565 p=.001		
4	PA skills	.535	.074	F(8,33)=.657 p=.725		
5	MA skills	.636	.100	F(4,29)=1.996 p=.122		
iii						
3	PA skills	.433	.265	F(8,37)=2.161 p=.054		
4	MA skills	.609	.176	F(4,33)=3.719 p=.013		
5	RAN skills	.636	.026	F(4,29)=.518 p=.723		

Table 5.9 presents the results of longitudinal regression predicting Time 2 Reading Comprehension for Grade 4 moving to Grade 5 children. In this case, phonological awareness measured at Time 1 explained an additional 5.9% of variance in reading comprehension administered at Time 2 beyond the contributions of morphological awareness and other relevant variables. In contrast, Time 1 morphological awareness predicted 19.7% of unique variability in Time 2 reading comprehension beyond the contributions of phonological awareness and the other control variables. And Time 1 RAN accounted for 16.2% unique variance in Time 2 reading comprehension after controlling for the effects of earlier morphological awareness, phonological awareness and other relevant variables.

These results indicated that earlier morphological awareness made a significant contribution to subsequent reading comprehension and that earlier RAN also accounted for a significant portion of unique variance in Time 2 reading comprehension, whereas phonological awareness only accounted for a small portion of unique variance, which did not reach statistical significance.

Table 5.9. Longitudinal Hierarchical Linear Regression Predicting Time 2 Chinese Reading Comprehension for Grade 4 Children moving to Grade 5

	Step& variables	**R^2**	**R^2 change**	**Sig R^2change**	**Final Beta**	
1	Gender & Age	.047	.047	F(2,47)=1.150 p=.325	Gender	.160
					Age	.020
2	Receptive vocabulary	.208	.161	F(1,46)=9.374 p =.004	Receptive vocabulary	.335
i						
3	RAN skills	.405	.197	F(4,42)=3.482 p =.015	Picture naming	-.662
					Character naming	-.067
					Pinyin letter naming	.030
					Digit naming	.165
4	MA skills	.657	.252	F(4,38)=6.995 p =.000	Homophone discrimination	.521
					Homograph production	-.473
					Homograph discrimination	.255
					Homophone production	-.186
5	PA skills	.716	.059	F(8,30)=.775 p =.628	Final sound identification	.305
					Rhyme production	.093
					Ton identification	-.035
					Final sound deletion	.001
					Initial sound deletion	-.168
					Initial sound identification	-.221
					Rhyme identification	-.123
					Syllable identification	.033
ii						
3	RAN skills	.405	.197	F(4,42)=3.482 p =.015		
4	PA skills	.519	.114	F(8,34)=1.008 p =.448		
5	MA skills	.716	.197	F(4,30) =5.2 p=.003		
iii						
3	PA skills	.370	.162	F(8,38)=1.225 p=.311		
4	MA skills	.554	.184	F(4,34)=3.504 p =.017		
5	RAN skills	.716	.162	F(4,30)=4.278 p =.007		

Chapter 6

General Discussion

In the past few decades, phonological processing skills, along with letter-name knowledge has been believed to be related to reading levels in alphabetic languages (Bradley & Bryant, 1983). However, there is also evidence that this relationship between reading levels and phonological skills may be influenced by the type of orthography learnt (Everatt et al., 2004). For learning to read the logographic-based Chinese orthography, there is growing evidence that morphological processing skills, along with rapid naming, may be the key factors affecting reading development (Ho et al., 2002; Chen et al., 2009; Liao et al., 2008).

The main purpose of the present research was to investigate the relative importance of these various cognitive processing skills (i.e., phonological processing skill, morphological processing skill and rapid automated naming) for Chinese reading acquisition in primary-level school grades in mainland China. In the present study, cross-sectional and longitudinal methods were used in which several cohorts of children were tested from grades one, two and four (roughly 50 per grade), and then re-tested one year later, when they were in grades two, three and five respectively. Children's phonological awareness, receptive vocabulary, morphological processing skills, rapid naming speeds, and reading ability were measured. The results indicated that all these skills were associated with Chinese reading acquisition. However, variations were found across grade levels (and hence reading level/experience) that argue for the need to develop models of reading acquisition that are somewhat specific to Chinese reading, and which are worthy of further investigation – these major findings are discussed in the following sections.

Overall, the results indicated across-grade changes in the levels of prediction of Chinese reading levels provided by measures of phonological processing, morphological-based skills and rapid naming. In study 1, analyses argued for measures of phonological processing to be the larger predictor of Chinese character reading in the early grades (grade 1 and 2), but this had changed to morphological processing by grade 4. In these data, there was a clear pattern across the regression analyses for phonology to be the largest predictor in grade 1. In contrast, morphology was the larger predictor by grade 4. Interestingly, grade 2 seems to show something of a transition in which phonological and morphological measures explained roughly equal amounts of Chinese character reading variance (phonological measures were only slightly larger than morphology-based measures), with rapid naming explaining the least amount of variance, though this was only slightly less than the morphology measures: i.e., in grade 2, all three areas of processing may influence Chinese character reader to roughly similar extents.

In study 2, character reading analyses showed a similar pattern to that found in study 1. The phonological and morphological measures showed roughly equal amounts of variance explained for grade 2 children, but morphology was the larger predictor for grade 3 and 5 students. Rapid naming predicted the least amount of variability up to grade 5, when it produced larger explained values than the phonological measures. This pattern seemed to be followed for reading comprehension when phonology and morphology measures were considered: phonological measures were the better predictors in grade 2, but morphological measures were the larger predictors in grades 3 and 5. Rapid naming, however, was almost as large a predictor of reading comprehension as morphology in grade 3 and was the larger predictor by grade 5.

The longitudinal analyses were in the main consistent with the time 1 and 2 data. Phonology in grade 1 predicted the largest amounts of variability in character reading in grade 2. Phonology and morphology in grade 2 predicted reasonably large amounts of character reading in grade 3, with phonology showing the largest level of variability predicted. However, morphology in grade 4 was the largest predictor of character reading variability in grade 5; with phonology and rapid naming showing similar levels of prediction from grade 4 to 5. For reading comprehension, phonological processing in grade 1 was the largest predictor of grade 2 variability and showed almost equal levels of variability predicted as the morphology measures. Grade 4 measures of morphology and rapid naming were the larger predictors of reading comprehension in grade 5 – though with the former being potentially larger than the latter.

These results across three studies argue for a pattern of Chinese reading that involves phonological skills in early learning, but for morphology and rapid naming to become the more influential factors as reading skills develop. This change seems reasonably consistent across measures of character reading and reading comprehension, arguing for key skills across the reading process: from basic word identification to connected text understanding. However, the findings showed that all three skills are potentially important for Chinese reading development across the range of grades targeted in the current work.

Influences of phonological processing, morphological awareness, rapid naming in Chinese reading acquisition

The results of the present study indicated that phonological awareness, morphological awareness and rapid naming were all important predictors of Chinese reading. However, they also suggested that the importance of these three primary cognitive constructs for Chinese reading may vary across grade levels; and, hence, reading level/experience. Results of regression analyses indicated that the best predictor of grade 1 reading variables was phonological awareness, whereas for grade 2 reading level, all three (phonological awareness, morphological awareness and rapid naming) provided some level of prediction. However, by grades 3, 4 and 5, the morphological awareness and rapid naming measures were the better predictors of the reading variables included in the present study. Notably, after age, gender, vocabulary, phonological skills and rapid automatic naming were statistically controlled, morphological awareness significantly contributed to reading variance explained from grade 2 onwards; arguing for the importance of the skills assessed by measures of homophonic and homographic tasks, and the morphological construction task in Chinese character reading development across a range of reading levels following beginning reading. Moreover, the unique variance explained by rapid naming, especially for reading comprehension, increased with reading development; whereas the unique variance explained by the phonological awareness measures seemed to diminished with age/experience.

The role of phonological awareness in Chinese reading development

Researchers increasingly appear to be in agreement that most reading disabilities are caused primarily by deficiencies in phonological processing (Ackerman & Dykman, 1993; Adams, 1990). The present findings suggest that the relative contributions of phonological processing measures in predicting Chinese reading achievement differ from that for alphabetic-based orthographies (such as the data on English reading development – see introduction to this thesis). In the present study, the phonological awareness measures covered a range of phonological processing skills: from syllable and onset-rime tasks, to tone and phoneme tasks. These skills were found to be particularly crucial to beginning readers; however, the dominant role of these skills declined with reading development. For beginning readers (grades 1 & 2), phonological awareness was a good predictor of variance in character and text reading.

However, the level of variability explained became non-significant for intermediate readers (grade 3) and diminishes further for more experienced reader (grades 4 & 5).

The present findings arguing for an influence of phonological skills on reading development in Chinese children concurred with previous research demonstrating that phonological skills predict Chinese reading level among beginning readers (Huang & Hanley, 1997; McBride-Chang et al., 2008). Huang and Hanley (1997) conducted a one-year longitudinal study with 40 first grade students in Taiwan. They investigated whether phonological awareness skills before formal instruction predicted reading a year later. Three testing sessions took place just before the children had learned the alphabetic system Zhu-Yin-Fu-Hao, immediately after the children had learned Zhu-Yin-Fu-Hao, and finally, at the end of the first year of schooling. Huang and Hanley found that phonological awareness tasks correlated with character recognition at the three testing times and that early phonology predicted character recognition at the end of grade 1 after statistically controlling for the effect of IQ.

The findings obtained from the mainland Chinese students tested in the present work also suggested that phonological skills are the main predictor of literacy levels for beginning readers. This may be due to the focus on pinyin to support learning in the early grades of mainland Chinese schools. One of the major features of non-alphabetic Chinese writing is the potentially arbitrary relationship between sound and print. Each character is a syllable and none of the constituents (e.g., strokes) provide phonological structures (e.g., phonemes). The sound of a Chinese character is not directly determined by combining its orthographic constituents, which is quite different from the representation of sound in an alphabetic orthography as used in English. Due to this lack of phonetic cueing provided by Chinese characters, the Pinyin system has been used to represent the pronunciation of Chinese. In Mainland China (as opposed to Hong Kong, for example), children learn Chinese characters through being taught the more alphabetic script of Pinyin. Through Pinyin training, Chinese children can recognize the sound structure of Chinese syllables and develop skills in segmenting a syllable into its initial and final elements, and blend them together to form a syllable (Siok & Fletcher, 2001).

In mainland China, children start to learn the Pinyin script as soon as they start formal reading instruction in grade one; and characters are learned dependent on pinyin knowledge in grades 1 through to 2. It is considered that after Chinese children have learned pinyin, they are more likely to pronounce Chinese syllables accurately, and they should be able to read new Chinese characters with the aid of phonetic symbols. This pinyin (alphabetic script) knowledge, therefore, will be likely to promote the development of phonological awareness within these children and pinyin reading ability will also influence Chinese character reading levels. The present results support this interpretation in that they identified reasonable large and significant correlations between pinyin reading and character reading in early grades (r=.575 for grade 1; r=.590 for grade2). The features of the pinyin system, similar to grapheme-phoneme correspondence rules in alphabetic languages (Harris & Coltheart, 1986; Siok & Fletcher, 2001), should help to establish the link between sound and print. Considering the relationship between pinyin and Chinese character reading, and the importance of pinyin in early learning, the importance of phonological awareness in these early grades would be predicted – and the present findings supported this prediction.

The move away from pinyin learning to reading Chinese characters without the support of pinyin, therefore, may equally lead to a decreased in the usefulness of phonological skills in reading development in the middle primary grades. In textbooks in grade 3, the number of Chinese characters is increased while pinyin only appears along with uncommon characters. The decreased use of pinyin, therefore, is consistent with the decrease in reading variability predicted by the phonological awareness in the current study among grade 3 children. Additional, by grade 4 to 5, the use of pinyin in textbooks for reading instruction is removed further and only transcriptions of Chinese characters are used. Again, this is consistent with the further reduction in the level of reading variability predicted by the phonological measures in the higher grades (4 and5) included in the present research. It was possible that phonological awareness contributed to word reading through the learning of Pinyin, which needs to be futher investigated.

The role of morphological awareness in Chinese reading development

One of the main aims of the work conducted as part of this thesis was to examine the relationship between performance on the measures of morphological awareness and character/text reading skills of Chinese children. The present data confirmed that there are potentially important relationships between morphological awareness and measures of character reading and reading comprehension across the grades studied. These findings support important role in Chinese reading development of children's understanding of orthographic-meaning relationships and their ability to recognize more complex words based on their constituent parts. Interestingly, the level of prediction provided by morphological awareness in reading outcomes in grade 2 and onwards remained significant even after the influence of phonological awareness and other relevant variables (vocabulary and rapid naming) were controlled. The current results indicated that performance on such morphological tasks as those included in the present work consistently accounted for a significant unique variance in concurrent and subsequent reading variables for children between grade 2 and grade 5. In contrast, the lack of significant unique variance explained in grade 1 reading argues for morphological awareness to be more important for intermediate and skilled readers than for beginning readers. The present results were consistent with previous studies suggesting that morphological awareness predicted a significant amount of unique variance in reading single words and reading comprehension over and above phonological skills (e.g., McBride-Chang, 2011 et al ; Shu et al., 2006).

The association between morphological awareness and reading may be due to the way Chinese characters/words are formed. In Chinese writing, the basic unit is a character that usually corresponds to one morpheme. If learning to read involves the recognition of principles underlying a writing system, then phonological processing should be important for alphabetic orthographies whereas morphological awareness may be more important for Chinese. Moreover, the rich morphology of Chinese should influence learning. As discussed previously, more than 75% of Chinese vocabulary consists of compound words represented by two or more characters. In most cases, Chinese compounds are semantically transparent and the connection between the meaning of the individual characters and the meaning of the whole word can be inferred. For instance, in Chinese, several compound words would contain the morpheme 学 /xue2/ (study), such as学校 /xue2xiao4/ (school), 学生 /xue2sheng1/ (student), 学期 /xue2qi1/ (semester), 学费 /xue2fei4/ (tuition). Such morphologically complex words encourage learners to infer the meanings of unfamiliar words by using the constituent parts that are known.

The increased influence of Morphological awareness on reading in intermediate and upper primary grade might be due to the fact that starting from grade 3, reading instruction mainly focuses on understanding the meaning of characters, forming characters into two or multi-character words, and using characters to make sentences. As mentioned in the previous sub-section, pinyin becomes less important for character learning at this stage. Instead, orthographic-meaning correspondence rules may be applied to facilitate reading success.

Therefore, in the present research, morphological skills were identified as making significant contributions to reading development (both character reading and reading comprehension) concurrently and longitudinally from grade 2 and onwards. Previous research has also provided evidence of the facilitative role of morphological awareness in intermediate and upper primary school children's reading ability. McBride-Chang et al. (2007) found that morphological awareness was able to explain unique variance in grade 3 children's reading comprehension after controlling for several reading related skills. Similarly, Shu et al. (2006) studied the contribution of several reading related skills to literacy outcomes among fifth and sixth grade students and showed that performance on a morphological production task was the strongest cognitive correlate of reading outcomes even after the effects of vocabulary was statistically removed. Both of these studies were conducted with intermediate and skilled children (grades 3, 5 and 6) with a reasonable amount of literacy learning experience. Hence, the influence of morphological awareness on beginning reading was not been explored. The present data indicated that morphological awareness did not explain any significant unique variance in grade1 character reading; though it was significant in later grades. These findings would argue for the importance of morphological awareness in Chinese reading at middle and upper primary school year levels, once a certain amount of reading experience has been gained or following the move from pinyin-supported character reading to reading contexts in which pinyin is less likely to be used.

The role of rapid automatic naming in Chinese reading development

The present work provided evidence for the complex, yet potentially important, role of the skills associated with rapid automatic naming in Chinese reading development. The present results indicated that reading variance explained by rapid naming measures increased with reading development. This finding, that measures of rapid naming better predict Chinese reading for older children, can be contrasted with previous studies investigating alphabetic scripts which have suggested that the level of prediction provided by naming speed tasks correlates with the reading achievement of beginning readers and that its role becomes weaker as children gain more skills in reading with age (Togesen et al., 1997; Stanovich, Cunningham & Gramer, 1984).

Interestingly, rapid naming was found to be particularly important predictor of reading comprehension for intermediate and skilled readers in the current research. Rapid naming of digits and pictures contributed unique variance to reading comprehension in grades 3 and 5 after controlling for age, gender, vocabulary, phonological and morphological awareness. Past research has found that rapid naming predicts variation in Chinese reading fluency. Liao (2008) reported that rapid naming explained large amounts (47% and 54%) of unique variance produced by grade 2 and grade 4 readers in a one-minute reading task – and significant levels of prediction were identified after age and IQ were controlled. Unfortunately, reading comprehension was not examined in Liao's study, so direct comparisons cannot be made with the present data.

Rapid naming was found to be a particularly important predictor of reading comprehension for intermediate (grade 3) and older primary school children (grade 5) in the current work. This finding is consistent with previous studies that have demonstrated relationships between rapid naming and Chinese character reading and reading fluency in higher primary grades (Ho et al., 2004; Liao et al, 2008). Interestingly, the current results also suggested that rapid naming skill was a better predictor of reading comprehension than character reading for these Chinese children. This may be consistent with the longitudinal work by Bowers (1995) in which naming speed in Grade 2 made a unique contribution to reading comprehension in Grade 4 whereas phonemic awareness in Grade 2 accounted for a unique variance in word reading measures two years later. It has been argued that naming speed is a predictor of reading fluency, and that children with slow naming speed are more likely to have reading fluency problems compared with children with normal naming speed (Wolf & Bowers, 1999; Wolf et al., 2000). Wolf and colleagues (2000) argued that rapid naming incorporates attentional, perceptual, conceptual, memory, lexical, articulatory and phonological processes in addition to incorporating visual-orthographic information. It is probable that these processes involved in naming speed are similarly employed at a higher level of complexity in reading, such as text reading comprehension; though further investigation are needed to explore these speculations and explain the relationships between rapid naming and reading found across orthographies.

Theoretical implication

For the initial stage of Chinese literacy acquisition, the data reported in this thesis argue for phonological skills to be important for children to access the mental lexicon. This dominate role of phonology starts to fade over the grades tested, and the importance of morphology and the processes involved in rapid naming in lexical access begin to increase, suggesting some form of development process. Therefore, the theoretical implications of the results will be discussed with reference to the main type of reading models that seem most related to these findings: with respect to processing models of lexical access, and then with regard to developmental reading models.

Lexical Processing Models

The findings should increase our understanding of the linguistic factors involved in Chinese character recognition and Chinese text reading comprehension. These, in turn, should inform theories about how these processes occur across languages and/or orthographies. One such model, that proposes a universal (cross-language) framework for understanding reading development and the process of reading, is that proposed by of Frost (2012). Such a universal model would be linguistically and theoretically preferable to a multitude of models varying across languages.

Frost (2012) argues that we should rethink those theories that put phonology at the centre of the reading process, and instead begin to consider the part played by a morphemically based visual pathway to meaning in reading, reading development, and reading impairment. The present data were consistent with this perspective in that evidence for the importance of morphological processing to children's reading skills in Chinese was identified. Results from the studies of this thesis thus can be argued to provide evidence for Frost's universal view, and suggest a morphology-based pathway to meaning that allows skilled readers to compute the meanings of words without the need for phonological recoding. The findings from the studies of this thesis lend support for a "universal" central position of morphological awareness in reading skills development in Chinese.

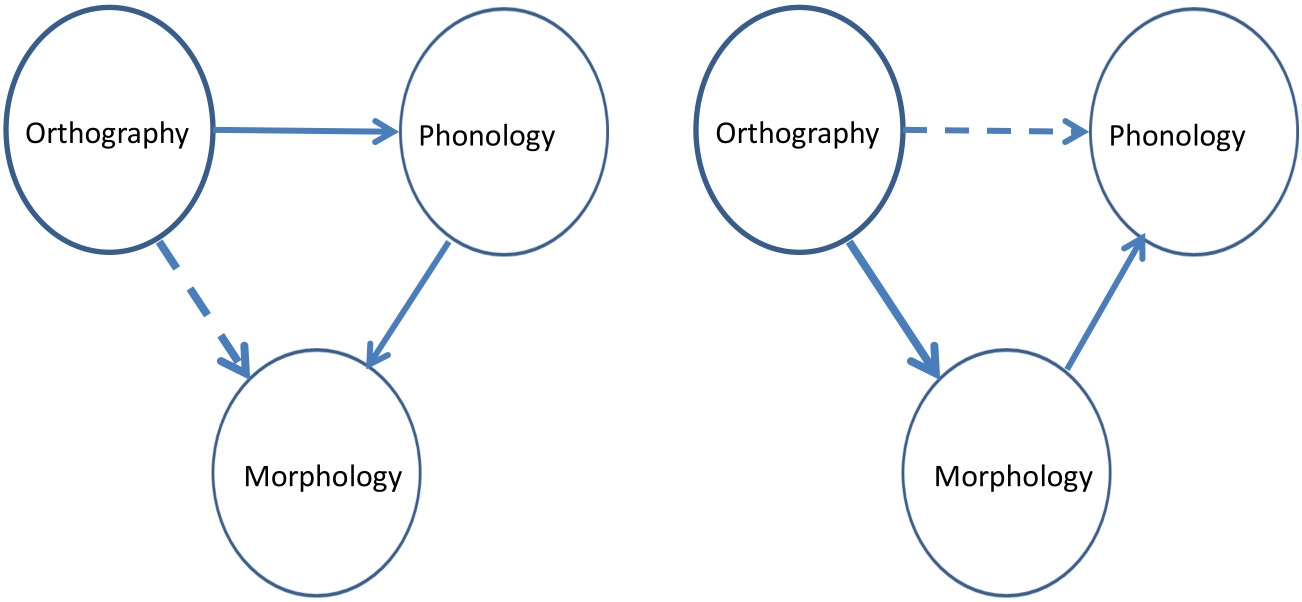
In many respects, the Chinese orthography presents the highest contrast with an alphabetic script. Given the morphemic (logographic) nature of Chinese characters, the question then arises as to whether universal cognitive processing (or lexical access processing) occurs in children learning to read different orthographies. Some researchers have suggested that cognitive processes in reading are not universal (Everatt et al., 2004; Katz & Frost, 1992). In a cross-linguistic comparative study conducted by Everatt et al. (2004) which focused on the assessment of phonological skills amongst English and Hungarian monolingual children with and without literacy deficits and bilingual Filipino children with and without literacy deficits in English. It was found that monolingual English children with poor literacy skills showed characteristic deficits in most areas of phonological ability, whereas the Hungarian counterparts showed little evidence of such difficulties. The authors concluded that phonological deficits may lead to literacy difficulties in certain scripts (e.g., orthographically deep scripts) but not others (i.e., highly transparent scripts). As such, literacy learning can be considered script-dependent. In general, the cross-cultural studies of the acquisition of basic reading skills among children learning to read different orthographies suggested that reading acquisition is directly affected by a specific writing system, raising challenges for such universal theories as that proposed by Frost (2012).

A model should take into account the phonology and morphology that orthographies represent. If the writing systems aim to provide morphological information, morphology would take the precedence and the role of phonological representations in word recognition would be underspecified or weak in the initial phase of lexical access. However, if orthographies aim to provide phonological information, then phonology would take the precedence over morphological representation in lexical access. Phonological awareness is put at the heart of reading acquisition for alphabets that follow regular grapheme-phoneme correspondence (GPC) rules while morphological awareness play a central role in reading process for logographs/morphographs in which the mappings between orthography and meaning are often systematic. The fundamental differences in the orthographies of languages may have significant implications for the way that words are recognized in each language and hence the way reading is acquired.

Chinese psycholinguistics literature has often focused on models that are either more phonological, or more semantic, in nature. These can be classed as phonological mediation models (such as the lexical constituency model of Perfetti et al., 2005) or semantically oriented direct access models. Phonological mediation models assume the primacy of phonology (Frost, 1998), or that semantic recognition follows from, and is mediated by, phonological recognition (see Tan & Perfetti, 1997; Perfetti et al., 2005). On the other hand, direct access models assume that word recognition (lexical access) is more semantically/orthographically driven, with phonological activation following, and being mediated by, semantics and orthography (see Zhou & Marlsen-Wilson, 1999).

The findings from the present study were more consistent with direct access models of skilled reading in Chinese, in that they suggest that morphological-based semantic activation as the primary route to lexical access for older rather than younger children. However, they also support the potential usefulness of phonological mediation, particularly in the early stages of reading acquisition. These ideas can be represented by the model presented in Figure 2, which presents a lexical model of Chinese reading based on the findings of the current study and previous studies.

Figure 2. Triangle model of Chinese readers: young readers to the left and older on the right



Consistent with alphabetic languages, early Chinese reading acquisition is more likely to depend on phonological ability, which may be attributable to the fact that the ability to recognize Chinese characters in young children is obtained through building up the association between orthography and phonology, and morphology (semantics) been accessed through phonology . However, in Chinese, children reduce the reliance on phonology, and develop direct links between orthography, morphology and semantics relatively quickly, due to the morphemic nature of the Chinese writing system which has relatively reliable associations with meaning. The present findings argue for a developmental transition around grade 2 which leads to a shift from phonology-dependence to morphology-dependence from grade 3 onwards.

One interpretation for the changes of reliance on phonology and morphology is that phonological skills may develop early and reach competence (possibly even ceiling) levels, which may be due to the relatively simple structure of the Chinese phonology. Morphological awareness is a more appropriate predictor when phonological awareness is not predictive of Chinese reading. A second possibility is the prevalence of Chinese homophones, which makes the access from phonology to semantics unreliable unless modulated by morphology when children acquire more characters. The models were discussed as proposals that might be tested in future research.

Developmental Models

The findings reported in the studies that comprise this thesis argue for varying effects of underlying phonological and morphological skills across grades. Such findings are more in line with developmental or stage model perspectives than models focusing on skilled reading. A variety of reading development models or theories have been proposed to describe the strategies children apply to learn to read. According to stage models (e.g., Frith 1985; Ehri, 1994), children pass through several developmental stages that overlap. In general, these models suggest that children pass through three or four stages in reading development, progressing from visual-logographic, alphabetic or phonological, to orthographic or analogical. In the initial visual-logographic stage, young readers use graphic characteristics of words, i.e., line drawings, strokes, as cues to identify and distinguish words. In the alphabetic or phonological stages, children begin to associate letters with sounds and grapheme-phoneme correspondences rules can be applied productively to learn new words. At the orthographic or analogical stage, children can make more meaningful use of higher-frequency or recurring forms (such as '–tion') , processing them as whole unites without decomposing. Additionally, children can potentially use analogy to read new words containing the same patterns as known forms; for example, reading 'bake' by analogy with 'take' (Ehri, 1994).

Based on the current findings, and previous empirical studies of reading among Chinese children, such models need to be revised to incorporate Chinese reading development. This may involve four stages: a visual-focused stage, a phonological processing stage, a morphological stage, and an orthographic or analogical stage. In the initial visual stage, preschoolers can recognize a few simple characters based on distinctive visual features, consistent with the findings of Ho & Bryant (1997) that children, as young as three years of age, can make use of visual features of characters. The present findings also argue for a second stage in which knowledge of pinyin would be helpful for Chinese children learning to read and in which phonological skills would be predictive of reading ability. This phase in reading acquisition then seems to change in dominance to more of a morphological stage in which children begin to associate characters with meanings and use these associations as cues to attend to written form of characters. In this stage, grapheme-morpheme correspondences rules can be applied when children learn to read new words, given the morphemic nature of Chinese; i.e., characters have direct associations with meaning as opposed to sound. At a final orthographic or analogical stage, children can make more efficient use of recurring patterns in characters, such as simple characters or radicals, processing them as whole units without decomposing: for example, the compound character 案 is based on the simple characters 安 and 木, and the compound character 付 based on a radical 亻 and simple character 寸. In this case, radicals or simple characters are unpacked as whole units when older, or more mature, readers learn new characters containing those familiar components. Moreover, orthographically similar characters could be learnt by using analogical strategies; for example, 治(treatment) and 冶(smelt) are similar in orthographic forms . 冶(smelt) may be recognized by analogy to 治(treatment) containing the same phonetic pattern "台". Skilled readers may use consistency information in a family of characters sharing the same stroke patterns (e.g., phonetic or semantic radicals) during character recognition. Anderson & Shu (1999) found that the ability to use semantic and phonetic radicals was predictive of reading ability in later school graders (fourth and sixth grade) and that good readers were able to make efficient use of the recurring patterns in characters.

The current findings particularly point to the significance of morphology in Chinese reading development which stage models (such as those of Frith, 1985, or Ehri 1994) need to take into account. The data also reveal that the reading stages that children go through can be affected by the writing system with which they are exposed. Katz and

Frost (1992) propose that differences in orthographic depth will lead to differences in processing. Shallow orthographies should easily support a word recognition process that involves the phonology, whereas a deep orthography requires printed words to be processed by referring to their meaning (or morphology) via the printed word's visual-orthographic structure. A similar argument that the level of transparency of the script may determine the relationships between basic literacy skills and phonological-processing measures was proposed by Smythe et al. (2008) based on 5 diverse languages backgrounds data. Whereas the relationships between literacy and phonological-processing measures was identified as strong for learners of low-transparency alphabet-based orthography, weak relationships between literacy and phonology were found when learning a highly transparent alphabet-based or non-alphabetic orthography. These authors further speculate that it may be that an awareness of morphology may support reading processes in some orthographies.

Chinese has generally been categorized as a opaque orthography because of its arbitrary relationship between the printed form and phonological representation. For example, Lukatela, Carello, Shankweiler and Liberman (1996) place English in the middle of an orthographic depth continuum, with Serbo-Croatian anchoring one end with the Romance languages whereas Hebrew (without diacritics) and logographic Chinese anchor the other end. In the Chinese writing system, the basic unit is a character that corresponds to one morpheme. If learning to read involves the recognition of principles underlying a writing system, then a phonological strategy should be important for alphabetic orthographies, whereas a morphological strategy may be more important for Chinese.

Since 1958, in Mainland China, Pinyin has been used to teach reading at the beginning of schooling. Pinyin is a phonemic representation of the language in Roman script and is a transitional alphabet used in literacy training. Children learn to transcribe Chinese words in Pinyin as a precursor to learning to read and write using the logographic characters ordinarily used for representing the Chinese language. Some researchers argue that phonological awareness does not occur automatically without learning to read an alphabetic orthography. Holm and Dodd (1996) conducted a study of four language groups from Mainland China, Australia, Hong Kong, and Vietnam. On phonological awareness tasks that included phoneme segmentation, spoonerisms, rhyme detection, and spelling, the subjects from Mainland China with training in Pinyin outperformed the Hong Kong students who were trained only in Chinese logographs. Similarly, Read et al. (1986) conducted a study in Mainland China which compared a group of readers who were taught to read the Chinese logographic system with a group who had learned logographs as well as Pinyin. The readers who had learned Pinyin in the study were able to add and delete phonemes better than the comparison group that had only learned to read Chinese logographic characters. Along with the current findings, such studies suggest that Pinyin learning may promote phonological development; which means that it is also possible that, for Chinese children without Pinyin learning (such as in Hong Kong), beginning readers apply grapheme-morpheme rules to recognize characters without passing through a phonological phase. The way Hong Kong children learn Chinese characters via a look-and-say whole-word approach based on rote memory without any phonetic tool may have an impact on the centrality of phonological awareness (at least at the level of the individual phoneme) in early stage of reading acquisition.

The current study suggests that there be a relatively quick shift from phonology stage to morphology stage during the reading development. One interpretation for this is that phonological skills develop early in Chinese due to the simple monosyllabic structure of Chinese. As argued by Smythe et al. (2008), the level of transparency of the scrip may determine, to some extent, the relationships between basic literacy skills and phonological processing strategy. The current study found weak relationships between literacy levels and phonological skill after children had experience of mastering a high transparent alphabetic orthography (Pinyin), and when an awareness of phonology does not seem to support Chinese reading. Although Chinese writing system is usually considered to be logographic, it might be more appropriately labelled as morphemic (Leong, 1973). Each Chinese character, as a basic writing unit, maps onto a single syllable morpheme rather than a phoneme in speech. A single morpheme is usually a word in the spoken language, although multimorpheme words are also common. The morphemic nature of the Chinese writing system makes the association between graphic forms and meaning strong. The relatively increased (high) levels of prediction of morphology of literacy levels demonstrated in current study suggest that morphological processing strategy support Chinese reading processes through primary school years. This is consistent with the Smythe et al. (2008) hypotheses that orthographic depth may determine the relationships between literacy and metalinguistic awareness. Differences in orthography experienced leads to differences in cognitive skills required for processing that orthography.

However, as argued by Beck (2005), the cognitive developmental factors underlying reading acquisition have not been accounted for in a stage model theory. The role of metalinguistic factors, such as working memory, in Chinese reading also need to be addressed in stage model study. Future comprehensive studies, varying age and grade level (i.e. from preschooler through middle school students), along with more controls for IQ, general language skills, vocabulary knowledge, and other linguistic factors could provide a clearer picture of developmental sequence of phonological, morphology, orthography and other developmental cognitive factors in Chinese reading development. The models were discussed as proposals that might be tested in future research.

Implications for practice

The findings of the present study have several possible implications for Chinese reading instruction and for assessment (and hence support) of the individual who shows difficulties in learning to read Chinese.

Implications for Assessment

The present study included a variety of phonological awareness tasks that allow researchers to examine students' phonological awareness from different perspectives. The findings suggest that among nine phonological measures, participants reached a high level of skill in the syllable awareness tasks, but found the final (single) phoneme tasks the hardest to perform. In Chinese, the final phoneme may be particularly difficult to identify because it often appears (and is taught) in a form that is larger than the phoneme. For example, the compound final pinyin symbol 'ang' is made up of two sounds: [a] and [ŋ]. In Chinese, teaching focuses on the unit 'ang' (pronounced / aŋ /) as a compound unit despite it consisting of two sounds (i.e., two phonemes). Although it is possible to segment this 'compound' into its constituent parts[a] and [ŋ], this is rarely considered. Hence, how children are taught will influence their respond to the task: Chinese students who have received instruction treating 'ang' as one unit may have greater difficulties in their ability to isolate a final phoneme than English children. The present findings provide support for this hypothesis. Final (single) phoneme discrimination or deletion tasks seemed to be more difficult for most children than syllable-based tasks. These results showed that phoneme awareness may be relatively weak when phonemes are not made explicit in Chinese.

As might be expected from models of phonological development (Goswami, 2000), phonological representations became more fine-grained with age in Chinese, and phonological awareness seemed to progress from the syllabic level via the onset-rime level to the phonemic level. Children showed good scores in measures of awareness of syllables early on, followed by tone awareness, and then by onset and rhyme awareness, whereas scores on phoneme awareness tasks still showed evidence of improvement in the higher grades tested, possibly consistent with later development. This reflects development from a global, holistic phonological representation towards a more fine-grained, segmentalized representation in Chinese children (see also Goswami, 2000). Furthermore, these Mainland Chinese children performed significantly better on the tone discrimination task than on the onset, rhyme and phoneme tasks across all grades. This argues for tone processing to be relatively a global phonological skill.

Moreover, the current findings indicate that the associations of different aspects of phonological awareness and Chinese reading varied as children develop with reading skills. Final Beta scores in the regression analyses revealed that syllable discrimination was associated with grade 1 character reading more so than the other measures of phonological skill in the study. This suggests that for beginning readers, syllable discrimination may be more appropriate measure of the construct of phonological awareness than other levels of phonological awareness tasks. Similarly, the Final Beta scores revealed that the rhyme discrimination task has the potential to explain the most variance in reading outcomes in grade 2 children; hence, for grade 2 students, rhyme awareness may be an important measure in phonological assessments.

Following a similar logic, the initial and final sound discrimination tasks may make better measures of phonological awareness at middle and upper primary school levels. Finally, tone awareness, as a suprasegmental phonological feature of Chinese syllables, has not been demonstrated to be an important predictor of Chinese literacy development in the current study. It might be expected that sensitivity to tones should be crucial for Chinese language-related skills (such as reading) since Chinese characters with identical phonological structure can be differentiated by tone. However, the present findings do not provide support for this hypothesis. One interpretation is that most of Chinese children have well developed tone awareness early in their schooling due to limited number of tones in Mandarin Chinese; i.e., there are only four tones in Mandarin Chinese. In order words, consistent levels of development of tone awareness across children beginning reading may make it no longer useful index for assessing children’s phonological awareness. However, future research with younger participants (pre-school children) is required to clarify the role of tone awareness in Mandarin Chinese.

A final point may be worthy of consideration for future assessments of phonological skills. In the current study children's performance on the phonological discrimination tasks was more predictive of reading than their performance on the deletion tasks. One possible reason may be that children were more likely to attend to the task completely when they had to discriminate sounds than when simply deleting a sound. Alternatively, the discrimination task may have required the children to analyze and manipulate the internal structure of Chinese phonology more so than the deletion tasks, requiring better phonological skills or more cognitive capacity. Taken together, the current findings provide support for a focus on certain types of phonological measures at different points in the development: the measures used need to be appropriate for assessing variability across the age/grade ranges targeted by the instrument.

The findings indicated that children's morphological awareness develops with grade level and was a significant predictor of Chinese character reading and reading comprehension across a range of ages/grades. In the present study, children's morphological awareness did not significantly predict their reading achievement in first grade beyond the other reading-related variables included. However, children's morphological awareness improved significantly in second grade and contributed more to the prediction of their reading skills than phonological awareness from grades two through five. This has been argued in this thesis to support the notion that Chinese children's reading development might be more related to morphological awareness rather than phonological awareness due to the morphemic nature of Chinese writing system. Such findings suggest that assessments of Chinese reading levels, and the cognitive factors underlying these levels, should include measures of morphological skills, at least after beginning reading levels.

Five morphological measures (homograph discrimination, homophone discrimination, homograph production, homophone production and morphological construction task) were developed to examine different aspects of morphological awareness. The measures in this study were mostly designed to assess the children's compound awareness at the word level and morphological structure awareness. Among them, the homograph discrimination task that required students to discriminate morphemes that share the same phonological and orthographic information, but differed in semantic information, was among the larger predictors of variability in Chinese children’s reading performance across grade levels. However, both the morphological construction task (which required recognition of the semantic/syntactic associations between morphemes) and the homophone discrimination task (that required students to discriminate morphemes that only shared the same phonological information) were significant predictors of character reading, particularly in younger, post-beginning readers (e.g., grade 2 children). Such measures (particularly the homograph and homophone discrimination tests) are recommended as measures to be included in assessment tools aimed at identifying children at risk of struggling with learning to read Chinese in the primary school grades due to underlying processing deficits.

Rapid naming was assessed by four tasks: naming of objects, digits, pinyin letters or simple Chinese characters. Among these measures, object and digit naming tasks were the better predictors of reading than the pinyin letter and simple character naming tasks. In the regression analyses, rapid object naming significantly predicted grade 2 and 4 character reading and grade 5 reading comprehension, while rapid digit naming significantly explained unique variance of grade 3 reading comprehension. These findings seem contrary to those reported by Liao (2008) who found that rapid naming tasks involving Zhu-Yin-Fu-Hao (similar to Pinyin) and simple characters were better predictors of reading than measures involving non-graphological items. A possible interpretation of the different results obtained in these two studies may be due to different stimuli used. In Liao's study, color naming was used as the non-graphological task, whereas in the present study, familiar objects were the non-graphological stimuli. Taken together, rapid naming may be used as initial device for screening of reading difficulties, particularly as such tasks are easy to construct, fast to assess, and make early diagnosis, prior to beginning reading development, possible. The current data argue for the use of object naming in such assessment tools; though further work may be needed to determine what specific aspect of rapid naming tasks leads to prediction of reading levels. The present findings suggest that even after lexical processing levels are explained by measures of phonological and morphological awareness, rapid naming still explains variability in Chinese reading performance, particularly in reading comprehension.One possibility may be the different level of processing associated with the tasks: phonological and morphological tasks may relate to lexical processing involved in segmenting word items, whereas rapid naming may be more associated with the processes associated with assessing items as a whole unit. Again, further research is needed, but the current data provide the basis on which to test such hypotheses.

Implications for Teaching

Orthographies can be classified into phonographic (alphabetic and syllabic) and logographic (Mattingly, 1992). In a logography, a meaning-based system, the basic unit of representation is the morpheme. The current study provided evidence that Chinese word recognition relies more on the morphology. Therefore, the current results suggest that children be taught to read in Chinese by focusing on morphological processing. However, it remains to be tested whether morphological processing development in language rather than literacy would be useful to reading development; i.e., is it the skill itself or the application of the skill within reading that is key to better acquisition.

In light of the current study showing the importance of morphological knowledge, an emphasis on the use of morphological information in compound words to facilitate students' understanding of words meanings seems highly desirable. For example, pedagogical activities that require students to contrast the meanings of homographic morpheme in multiple words should be designed to help students to consolidate the understanding of the words. Moreover, teaching methods requiring students to decompose words into characters (morphemes) and then use a single character (morpheme) as building units to form new two-three character words should be developed in reading instruction. Additionally, careful comparisons of words containing homophonic morphemes might help students distinguish the characters that pronounce similarly.Overall, the current findings direct the children's attention to morphemic units (meanings) when learning to read.

Although the current study suggested that phonological awareness skills were less predictive of Chinese reading skills than in other orthographies, such skills may still support reading performance in English as an additional language for Chinese students. For example, studies have provided evidence for cross-language phonological transfer. Wang et al. (2005) discovered that a certain level of phonological transfer occurred even when children learn to read two very different writing systems (Chinese and English). They showed that the ability to identify onsets in Chinese was correlated with English onset and rime skills. These authors concluded that bilingual reading acquisition was a joint function of shared phonological processes and orthographic-specific skills, and that children can build on the shared phonological mechanism of the two spoken languages when learning to read across different orthographies. In another study by Gottardo et al. (2001) on Chinese children (Cantonese speakers in Canada) who learnt English as a second language, phonological processing skills in children's first language were related to decoding skills in English (an alphabetic orthography). These studies point to the importance of transfer of a child's first language phonological skills to second language processing even if the two orthographies are entirely different.

Further evidence suggests that the ability to identify the sounds within the words depends in part on being able to read an alphabetic orthography. In the study by McBride-Chang et al. (2004), Hong Kong children without Pinyin training were able to recognize more Chinese characters than Xian (Mainland China) children with Pinyin training. However, the Hong Kong children's ability in syllable and phoneme onset deletion tasks was poorer than the Xian children. This was also the case when compared with Toronto bilingual children. Similarly, phonological tasks showed no significant correlation with word recognition in Hong Kong children but did for the Toronto and Xian children. These differences support the idea that development of phonological awareness differs across orthographies and language instruction method. Alphabetic literacy learning (such as Pinyin training) may promote the development of phonological awareness.

Hence, learning an alphabetic orthography (Pinyin) may have a beneficial effect in developing phonological skill that have been shown to support reading and writing development in English. However, the current findings suggest that children from Mainland China also have relatively low phonemic awareness skills (as measured by final single phoneme detection and deletion tasks). Therefore, it remains to be tested if cross-language phonological transfer from Chinese to an alphabetic language (such as English) only exists at the onset-rime level, but not at the phonemic level, due to the focus on the onset-rime level during Pinyin training and the low level of phonemic awareness skills. For example, previous research has indicated that readers learning a logographic-based orthography as their first language tend to rely on reading strategies that are consistent with this logographic background when reading English as a second language (Koda, 1994). Hence, if Pinyin training does not facilitate the development of phonemic awareness skills that predict reading achievement in alphabetic writing systems such as English, additional training of phonological awareness skills at the level of the phoneme may be needed to support acquisition of the alphabetic principle. Training in grapheme-phoneme correspondences would allow Chinese English second language learners to phonologically process and analyze English words, develop the skills necessary to approach the pronunciation and spelling of English words. This training may need to be explicit and linked to reading for Chinese learners of English as a second language to be able to use the phoneme-grapheme correspondences rules that support the development of English alphabetic reading.

Developmental models should be helpful for informing classroom instruction. Chinese first language teachers increasing their understanding of character and text reading, and the stage of reading developmental that their students are going through, should allow them to apply informed pedagogical methods appropriate to the age, grade or ability level. In light of the current research, and other developmental studies, showing the relevance of phonological and morphological knowledge, an emphasis on Pinyin training at the beginning stage of reading, and the use of morphological structure of words to facilitate students' understanding of word meanings at later stages of reading development, seems highly desirable.

Limitations

This study had several limitations that should be kept in mind when generalizing findings. First, the sample used in the present study was relatively small (roughly 150) and was geographically restricted. Therefore the findings may not apply to other Chinese speaking children in other parts of the world (e.g., Hong Kong) whose reading instruction is different from that of Mainland Chinese children.

Second, there are other skills that may be related to Chinese reading acquisition in primary grades that were not assessed in the present study; for example, orthographic processing skills. Previous research has provided evidence for the importance of visual-orthographic awareness in Chinese reading (e.g., Ho et al., 2004). Therefore, further research will be needed to include these additional aspects when determining the developmental pattern of cognitive factors and Chinese reading.

The time allowed for PhD work meant that the longitudinal aspect of the research was restricted to one year only. Also, in order to be able to cover a relatively wide range of year groups in the study, there were gaps in those studied: in phase 1, Grade 3 was not covered (though it was in phase 2). Again, further research would be worthwhile covering all primary grades at each phase of the study and which follows children over a longer period of time: across the first four years of learning would be useful to show the changes in predictors within the same cohort of students.

Future research

The current study showed that phonological awareness was related to the early development of students' reading ability rather than later stage. It is possible that the early learning of a phonetic script may facilitate the development of phonological awareness and a relationship between phonological awareness and reading ability. Children in Hong Kong are generally taught to read Chinese characters without being taught Pinyin: they are usually taught character-to-pronunciation mappings without the aid of an alphabetic script. That is to say, they learn Chinese reading via a look-and-say, whole-word approach based on rote memory without any phonetic tools (Huang & Hanley, 1995). It could, therefore, be argued that visual processing and/or morphological skills are vital for Hong Kong students to achieve reading success at the early stage of reading development. Future studies with a larger, more geographically representative population (e.g., including Hong Kong children) would be required to determine if the current findings are replicable across these different context. Such future research could include an examination of visual-orthographic, phonological and morphological (semantic) factors at different ages and grade levels (with controls for cognitive developmental factors), to further inform the developmental sequence of reading in Chinese. Analyses across learning contexts

(Mainland China versus Hong Kong) would allow the effects of instruction (pedagogy) on reading developmental to be considered alongside cognitive and linguistic factors.

Conclusions

There are numerous factors involved in the acquisition of reading and writing. It seems logically plausible that failure in any one will result in reduced effectiveness in literacy acquisition. The results of the present study indicated that phonological awareness, morphological awareness and rapid naming were all important predictors of Chinese reading. However, they also suggested that the importance of these three primary cognitive constructs for Chinese reading may vary across grade levels; and, hence, reading level/experience. Results of regression analyses indicated that the best predictor of grade 1 reading variables was phonological awareness, whereas for grade 2 reading level, all three (phonological awareness, morphological awareness and rapid naming) provided some level of prediction. However, by grades 3, 4 and 5, the morphological awareness and rapid naming measures were the better predictors of the reading variables included in the present study. Notably, after age, gender, vocabulary, phonological skills and rapid automatic naming were statistically controlled, morphological awareness significantly contributed to reading variance explained from grade 2 onwards; arguing for the importance of the skills assessed by measures of homophonic and homographic tasks, and the morphological construction task in Chinese character reading development across a range of reading levels following beginning reading. Moreover, the unique variance explained by rapid naming, especially for reading comprehension, increased with reading development; whereas the unique variance explained by the phonological awareness measures showed evidence of diminishing with age/experience.

The current work argues for the importance of incorporating various processes in a model of literacy, if cross-language differences are to be accommodated. Based on the current findings, together with the available evidence in the literature, a revised stage model was proposed that better explains Chinese reading development. This involved four stages: a visual-focused stage (which will have features similar to a logographic stage), a phonological processing stage (which would be similar to an alphabetic stage, but which may need to consider the level of processing of phonological forms to explain the more syllable-level focus of Chinese), a morphological stage (to explain the importance of developing morphological skills for fluent reading of Chinese characters), and an orthographic or analogical stage (with the primary feature of fluent processing of characters). Overall, the findings support arguments for different processes to be incorporated in the acquisition of literacy across orthographies, or the application of the same processes but to different degrees across different languages. As such, it seems highly plausible that the underlying cognitive demands for successful acquisition in literacy will vary across languages/orthographies.

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Appendices

Appendix A:　Phase 1 Measures

Syllable deletion

指导语：嗨，我现在教大家玩一个游戏，有一些双字词（两个音节），听我说出这些词，然后我会去掉一个音节，您能告诉我还剩下什么？

练习（1）例如：月亮，如果去掉“月”，你告诉我还剩什么？

对，只剩下“亮”，（　（如果学生答错，则加以解释）测试：

1.　明亮　(去掉第一个)

2.　花朵（去掉第二个）

3.　声音（去掉第二个）

4.　上学(去掉第一个)

5.　太阳（去掉第二个）

6.　时间（去掉第二个）

7.　知道(去掉第一个)

8.　方向（去掉第二个）

9.　请客（去掉第二个）

10.老师(去掉第一个)

11.逐渐（去掉第二个）

12.枢纽(去掉第一个)

13.摆弄（去掉第二个）

14.池塘(去掉第一个)

15.之前(去掉第一个)

Syllable Identification

练习（1）

例如：我说“冬天 冬瓜 谈话 ”， 这三个词当中，有一个词与其他词没有共同的音节，你能告诉我是哪一个词吗？

对，应该是“谈话“，（ （如果学生答错，则加以解释）

测试：

1. 年级 整齐 上级

2. 高兴 人们 兴奋

3. 朋友 百合 友爱

4. 队长 鲜花 花草

5. 开会 学生 开始

6. 明亮 笑话 亮光

7. 美丽 骂人 美好

8. 认真 合作 认识

9. 丰收 和气 和平

10. 主人 权利 主要

11. 海洋 鲜艳 太阳

12. 天气 大水 空气

13. 发现 熊猫 涌现

14. 学校 寻找 学费

15. 宝贝 评论 苹果

Initial Sound Identification

练习（1）

例如：我说"1. juan jiang xian "这三个音节当中，有一个音节与其他音节没有共同的声母，你能告诉我是哪一个吗？对，应该是"xian"，与其他声母不同（（如果学生答错，则加以解释）

测试：（所有测试题声调保持一致）

1. xiao xue qiang
2. gao kai gai
3. qiao lao liang
4. han tan huan
5. bao dao bang
6. tao len tan
7. kao han kan
8. dao dun tang
9. yan wen yao
10. qian xiong qiao
11. cao song cuan
12. zuan zan tang
13. shui rou shen
14. xie zhuo zhuang
15. xian qiong que

Initial Sound Deletion

练习（1）

例如：听我读出这个音节ban，请告诉我去掉开头部分（声母），还剩下什么?

对了， 只剩下an.

（如果学生答错，则加以解释）

测试：（所有测试题声调保持一致）

1. nuan
2. chang
3. feng
4. kang
5. jia
6. qiong
7. shuai
8. cuan
9. juan
10. suo
11. liang
12. lue
13. hui
14. guo
15. shuang

Final (Single) Sound Identification

练习（1）

例如：我说“ba　fa　se　”,大家仔细听，告诉我哪一个的尾音与其他的不一样？”

对，应该是“se”，与其他尾音不同（（如果学生答错，则加以解释）

测试：（所有测试题声调保持一致）

1. lai　jia　dai
2. lao　tiao　luo
3. fu　la　tu
4. ti　fei　li
5. bo　fa　wo
6. huai　hua　jia
7. pin　leng　yun
8. chun　sheng　dong
9. pan　liang　xun
10. fei　pei　bie
11. yue　nie　xue
12. jun　lan　feng
13. sheng　qiong　lin
14. lei　dui　kui
15. tou　huo　sou

Final (Single) Sound Deletion

指导语：“嗨，我现在教大家玩一个游戏，大家知道每一个音节包括很多音素，例如 hang 包括 h, a, ng,三个音素，请告诉我去掉尾音，也就是最后一个音素，还剩下什么？”“对了， 只剩下 ha. ”（如果学生答错，则加以解释）。我们再练习一次：“man，去掉最后面的音，剩余的音应该是什么呀？”“对了， 只剩 ma”.好的，做的很好啊，下面我们开始正式测试。（所有测试题声调保持一致）

1. man
2. leng
3. ling
4. jun
5. qia
6. guan
7. zhuan
8. chuang
9. huai
10. shen
11. yang
12. xin
13. xian
14. huo
15. lie

Rhyme Detection

练习：

例如：听我读出三个音节 **hang sheng deng**,你能告诉我哪个不押韵吗?

对，应该是**hang**（如果学生答错，则加以解释）

好的，做的很好啊，下面我们开始正式测试。（所有测试题声调保持一致）

1. quan jian xuan
2. min xun jin
3. jie yue tie
4. gong feng kong
5. chuan pian bian
6. yue quan xue
7. xuan qun yun
8. duan teng tuan
9. bie hui nie
10. chuo jiao zhuo
11. luo tui cui
12. zhuang chuan shuang
13. teng mang feng
14. liao huai tiao
15. fang chuan huan

Rhyme Production Task

练习(1) 例如：听我读出两个音节 fan lan ,你能造出与他们押韵的音节吗？对，例如 man tan shan zhan 等。（如果学生答错，则加以解释）练习（2）好，让大家再试一次。

听我读出两个音节shuang zhuang ，你能造出与他们押韵的音节吗？ 对, 例如chuang, huang ,(如果学生答错，则加以解释）

测试: （所有测试题声调保持一致）

1. hang bang

2. bian pian

3. dan tan

4. qing ling

5. huan luan

6. keng leng

7. chuan zhuan

8. jun qun

9. quan juan

10. jin xin

11. sheng deng

12. jun xun

13. qiao liao

14. rong hong

15. shen zhen

Tone Detection

练习（1）

例如：听我读出三个音节qī hū bái ，你能告诉我哪一个的音调不一样吗?

对，应该是 bái 。 (如果学生答错，则加以解释）

测试:

1. bāo pái cān
2. qíng chú liāng
3. fěi qiáo xuě
4. huí tóng jǔ
5. qín zhǐ bǎi
6. mà chòu zhí
7. qìng jí cí
8. bái féi fàn
9. táng hù bài
10. tǒng xuě zhí
11. zhí laō bái
12. mǎ fěi guó
13. chòu qíng qì
14. měi zhǎng fāng
15. fèi qiáng má

Homophone Discrimination

指导语：

例如：我说“ 画家 ，图画 说话 ,” 都含有一个同音字“**hua**”,但其中有一个**hua**的意思及字形与其他两个是不一样的，你能告诉我哪一个是不一样的吗？

对了，你应该把 “说话 ”挑出来。（如果学生答错，则加以解释）

好的，下面我们进行正式测试。仔细听啊！

1.远近，进 出、前进 、

2.员 工、草原 、少先队员

3.经常 、长 短、平常

4.起飞，非 常，是非

5.童 话、同 样，童年

6.声音、生 活、生 命、

7.冬 天、东 方、冬日

8. 风雨、语 文、语 气、

9.以 前、已 经，以往

10.明白、 名声、明显

11.座 位、做主，让座

12.方向、头像 、画像

13.再 度、现在，再 次

14.工 人、 工 业、外公

15.力量 、明亮，闪亮

Homograph Discrimination

练习（1）例如：我说“月光 (moonlight), 月色 (moonbeam), 年月 (date)”,这三个词都含有“月”，但其中“月”在一个词中的意义与其他两个不同，你能告诉我哪一个是不一样的吗？

对了，你应该把“年月(date)”挑出来。（如果学生答错，则加以解释）

好的，下面我们进行正式测试。仔细听啊！

1.开会 开阔 开课

2.光线 光芒 春光

3.打扰 打动 打搅

4. 充裕 充足 充实

5. 图画 图案 图谋

6.调整 调皮 调理

7.深情 深浅 深水

8.领会 会合 会面

9.生疏 生根 生长

10. 透彻 透气 透热

11.衣服 信服 服饰

12.笔直 伸直 直率

13.狂风 风情 风雨

14.知道 知晓 良知

15.打折 折服 折扣

Homophone Production Task

练习：

例如：我说 ：“ 河水， 禾苗”，这对词都含有同音字“河，禾”字，那么你可不可以也组一个词，这个词也含有“河”或“禾”的同音字呢？对了，你可以组另外一个词“和平”，“和 ，禾， 河”它们都是同音字

好的，下面我们开始正式测试了！

1. 圆形 公园 **(**圆 园**)**

2. 学生 上升 **(**生 升**)**

3. 方向 大象 **(**向 象**)**

4. 图画 变化 **(**画 化**)**

5. 坐下 让座 （ 坐 座）

6. 铁钩 打勾 **(**钩 勾**)**

7. 木头 日暮 （木 暮**)**

8. 车站 占领 **(**站 占 **)**

9. 宫殿 办公 **(**宫 公**)**

10. 试题 式样 **(**试 式 **)**

11. 捡起 检查 **(**捡 检**)**

12. 申请 呻吟 **(**申 呻 **)**

13. 计划 记录 **(**计 记**)**

14. 厉害 历史 **(**厉 历**)**

15. 山峰 锋利 **(**峰 锋**)**

Homograph Production

练习：

例如：我说 ： “会议”，“开会”这对词都含有“会”字，那么你可不可以也组一个词也含有“会”字，但“会”字在你组的词中意义与其他两个不同，对了，你可以用“会”字组另外一个词“会面”，其中“会”字的意义不同于其他两个。（如果学生答错，则加以解释）

好的，下面我们开始正式测试了！

1. 活动 活泼（活）
2. 明亮 亮光（亮）
3. 办法 办公 （办）
4. 工厂 工人（工）
5. 同样 相同（同）
6. 舒适 适合 （适）
7. 运用 命运 （运）
8. 安静 宁静（静）
9. 通过 交通（通）
10. 参观 观看（观）
11. 足迹 痕迹 （迹）
12. 指点 指导（指）
13. 益虫 日益（益）
14. 光线 春光（光）
15. 抽取 抽穗（抽）

Digit Naming

指导语：

请你大声读出下面的数字，按照从左到右，从上到下的顺序读完。读得越快，越准确越好，不限制时间。

2 4 5 7 9 4 2 5 9 7

5 7 4 9 7 2 4 9 5 2

4 2 5 4 5 7 9 2 7 4

7 5 9 2 7 5 4 5 2 9

5 4 7 9 4 9 2 4 9 5

Pinyin Letter Naming

指导语： 请你大声读出下面的拼音字母，按照从左到右，从上到下的顺序读完。读得越快，越准确越好，不限制时间。

b p f n l p b f l n

f n p l n b p l f b

p b f p f n l b n p

n f l b n f p f b l

f p n l p l b p l f

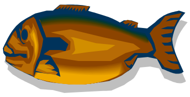
Simple Character Naming

指导语：　请你大声读出下面的简单汉字，按照从左到右，从上到下的顺序读完。读得越快，越准确越好，不限制时间。

大	天	少	不	小	天	大	少	小	不
少	不	天	小	不	大	天	小	少	大
天	大	少	天	少	不	小	大	不	天
不	少	小	大	不	少	天	少	大	小
少	天	不	小	天	小	大	天	小	少

Picture Naming

指导语：　请你大声说出下面的简单图片，按照从左到右，从上到下的顺序说完。说得越快，越准确越好，不限制时间。



Pinyin Reading

指导语：

好的，下面请同学们读出下面的拼音，第一部分为单个拼音，第二部分为拼音词组，读的越快越准确越好。

好的，现在测试开始了。

hé　tǔ　báo　zhōng　bù　mù　bái　ěr　tǔ

diàn　cháng　chū　yún　gōng　guǎng　shēng

pí　zǒu　bàn　píng　zú　lǐ　zhèng　yī　mǎ　yá

shēng　máo　yáng　tiān　wén　rù　jiàn　shān　chē

shǎo　shuǐ　bā　yè　piàn　shēng　qín　chū　páo　zào

cāo　zōng　yǐng　tiàn　hèng

yìn shuā　jiū chán　cōng yù　fèng huáng　jīqì　tú

dì　kòng xì　yú gāng　qízhì　wēnnuǎn　mín zú　bō

làng　cāo chǎng　róng yì　zhù fú　gào sù　jiào

shì　qū fēn　bèn zhuó　shuǐ ling　núlì　gāo xìng

lǎo shī　shēng qì　fā xiàn

Character Reading

指导语： 请大声读出下面的汉字或词组，按照从左到右，从上到下的顺序，读的越快，越准确越好。

好的，现在测试开始了。

舟 爪 钟 虾 男 解 梅 爬 船 弓

护 扇 秋 桥 草 吹 裳 兔 梯 希

翻 沾 慢 朋 桥 站 银 商 角 项

零 醒 移 曲 洞 揣 搏 绸 禽 嵌

昂 揪 凹 鞭 崖 泊 堪 詹 盟 痕

恙 涸 潺 檐 盎 璞 曦 桅 琢 杼

万里 百合 齐全 说明 友人

春秋 高级 行李 新秀 机会

红叶 草地 尤其 赶快 江河

完美 决定 题目 动物 随便

背景 游泳 技术 树林 彩虹

勇敢　　蚂蚁　原谅　本领　翅膀

旅行　　浪费　微风　端详　珊瑚

挖掘　　漂浮　巡回　恐怖　湖畔

堤坝　扫荡　溃烂　蹉跎　黯然

激励　慷慨　驱逐　鞠躬　贪婪

瑕疵　凛冽　浩渺　懈怠　耽搁

漩涡　瞻望　蓑笠　摇曳　豁免

Nonword Reading

指导语：

好的，下面请同学们试着读一些词语，这些词在现实中并不存在，但我们可以把这些词语读出来，让我们一起来试试看。

练习(1):

例如：让大家读“飞空”这个词，这个词在我们的生活中并不存在，但我们可以读出它来。大家告诉我怎么读？

对了。很好！

好，让大家再试一次。

练习(2)

例如：“学桌”这个词，这个词在我们的生活中并不存在，但我们可以读出它来。大家告诉我怎么读？

对了。很好！

下面我们进行正式测试，大家读出下面的词。读的越快越准确越好

生友 走学 本上 天飞 月见 光可 水方 周者 光性
伦学 反孤 无生 毒化 点度 林儿 仿然 可俏 文者 去化
好员 黑器 显斜 重群 躯浑 辟遭 挖鞋 瀑炉 促企
纠掏 稿腔 拽水 赐励 颤魂 焰熏 疚惧 梢膝 附障 嘱掩
荀销 覆衔

Non-Syllable Reading

指导语：

好的，下面请同学们试着读一些拼音音节，这些音节在现实中并不存在，但我们可以把这些音节读出来，让我们一起来试试看。

练习(1)

例如：让大家读“fao”这个音节，这个音节在我们的生活中并不存在，我们也可以叫它“假音节”，但我们可以读出它来。大家告诉我怎么读？

对了。很好！

好，让大家再试一次。

练习(2)

例如：“bou” 这个音节，这个音节在我们的生活中并不存在，我们也可以叫它“假音节”，但我们可以读出它来。大家告诉我怎么读？

对了。很好！

下面我们进行正式测试，请大家读出下面的假音节。读的越快越准确越好

pia	**dua**	**nuang**	**luai**	**kian**	**gie**
miang	**fieng**	**xuai**	**liong**	**juang**	**chiao**
muen	**fui**	**jei**	**xou**	**zhie**	**ten**
kin	**bou**	**chiu**	**qai**	**nui**	**tue**
zuai	**chiang**	**zhian**	**hiu**	**jan**	**chueng**

Appendix B: Phase2 Measures

Initial Sound Identification

练习（1）

例如：我说“1. juan jiang xian ”这三个音节当中，有一个音节与其他音节没有共同的声母，你能告诉我是哪一个吗？对，应该是“xian”，与其他声母不同（ （如果学生答错，则加以解释）。测试：（所有测试题声调保持一致）

1. xiao xue qiang
2. gao kai gai
3. qiao lao liang
4. han tan huan
5. bao dao bang
6. tao len tan
7. kao han kan
8. dao dun tang
9. yan wen yao
10. qian xiong qiao
11. cao song cuan
12. zuan zan tang
13. shui rou shen
14. xie zhuo zhuang
15. xian qiong que

Final (single) sound identification

练习（1）

例如：我说“ba　　fa　　se　　”,大家仔细听，告诉我哪一个的尾音与其他的不一样？”

对，应该是“se”，与其他尾音不同（　（如果学生答错，则加以解释）

测试：（所有测试题声调保持一致）

1. lai　　jia　　dai
2. lao　　tiao　　luo
3. fu　la　　tu
4. ti　fei　　li
5. bo　　fa　wo
6. huai　hua　　jia
7. pin　　leng　　yun
8. chun　　sheng　　dong
9. pan　　liang　　xun
10. fei　　pei　　bie
11. yue　　nie　　xue
12. jun　　lan　　feng
13. sheng　　qiong　　lin
14. lei　　dui　　kui
15. tou　　huo　　sou

Rhyme Detection

练习：

例如：听我读出三个音节 hang sheng deng,你能告诉我哪个不押韵吗?

对，应该是hang（如果学生答错，则加以解释）

好的，做的很好啊，下面我们开始正式测试。

测试：（所有测试题声调保持一致）

1. quan jian xuan
2. min xun jin
3. jie yue tie
4. gong feng kong
5. chuan pian bian
6. yue quan xue
7. xuan qun yun
8. duan teng tuan
9. bie hui nie
10. chuo jiao zhuo
11. luo tui cui
12. zhuang chuan shuang
13. teng mang feng
14. liao huai tiao
15. fang chuan huan

Homograph Discrimination

练习（1）例如：我说“月光 ，月色，年月”,这三个词都含有“月”，你能告诉我哪一个词中的“月”字与其他两个意思不同？对了，你应该把“年月(date)”挑出来。（如果学生答错，则加以解释）

练习（2）再试一次。例如：我说“老少 年老 老手””,这三个词都含“老”，你能告诉我哪一个词中的“老”字与其他两个意思不同？对了，你应该把 “老手”挑出来。（如果答错，则加以解释）。开始测试。

1. 报答 报考 报案

2．神采 神情 神话

3．察觉 视觉 觉悟

4．书本 剧本 资本

5．防备 预备 设备

6．木板 古板 地板

7．起点 焦点 沸点

8．候补 弥补 滋补

9．冷淡 暗淡 素淡

10．证据 收据 占据

11．核查 核心 核实

12．帮忙 帮派 帮手

13．细密 密谋 茂密

14. 发表 发现 发言

15. 关注 关联 关心

Morphological construction task

练习：例如：我说“长着花尾巴的狗，我们叫它花尾巴狗，那么长着花尾巴的大象，我们叫它什么?” 对了，你应该说”花尾巴象”.

测试：

1.有一种衣服是用来防雨的，我们叫它雨衣，那么有一种房子是用来防雨的，我们叫它什么？

2.如果有个瓶子，是用来装酒的，我们叫它酒瓶，如果有个瓶子是用来装土的，我们叫它什么？

3.用来装水的桶，我们叫它水桶，用来装豆的桶，我们叫它什么？

4．有一种猴子，尾巴很长，我们叫它长尾猴，那么有一种猪，尾巴也很长，我们叫它什么？

5.树上落下的叶子叫落叶，那么树上落下的虫子，我们叫它什么？

6. 有一种蛇,尾巴会响,我们叫它响尾蛇,那么有一种猫,尾巴也会响，我们叫它什么？

7．有一种车，是用脚蹬的，我们叫它脚蹬车，那么另外有一种车，是用腿蹬的，我们叫它什么？

8. 可以用来放书的架子, 我们叫它书架, 那么可以用来放笔的架子，我们叫它什么？

9．有一种杯子是用来冲咖啡的，我们叫它咖啡杯，那么有一种杯子是用来冲米糊的，我们叫它什么？

10．山背着太阳的一面叫山阴，那么河背着太阳的一面，我们叫它什

么？

11．傍晚，我们看到太阳落下，我们叫它日落，那么晚上，我们看到云彩落下，我们叫它什么？

12．当我们想让我们的血管更加柔软，我们说我们将要软化我们的血管，那么如果我们想让我们的骨骼更加坚硬，我们说我们将要对我们的骨骼怎么样？

13．长着金色长毛的猴子，我们叫它金丝猴，那么长着金色长毛的兔子，我们叫它什么？

14．夜间能发光的珠子，我们叫它夜明珠，那么夜间能发光的杯子，我们叫它什么？

15. 用来拍苍蝇的拍子，我们叫它苍蝇拍，那么用来拍老鼠的拍子，我们叫它什么?

Digit naming

指导语：

请你大声读出下面的数字，按照从左到右，从上到下的顺序读完。读得越快，越准确越好，不限制时间

2 4 5 7 9 4 2 5 9 7

5 7 4 9 7 2 4 9 5 2

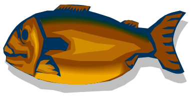
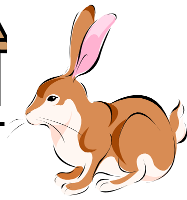
4 2 5 4 5 7 9 2 7 4

7 5 9 2 7 5 4 5 2 9

5 4 7 9 4 9 2 4 9 5

Picture Naming

指导语：　请你大声说出下面的简单图片，按照从左到右，从上到下的顺序说完。说得越快，越准确越好，不限制时间。

Character Reading

指导语： 请大声读出下面的汉字或词组，按照从左到右，从上到下的顺序，读的越快，越准确越好。

好的，现在测试开始了。

谙 皑 馈 铛 絮 谐 檀 络 谧 惬
诣 潺 涸 隶 骋 雏 寐 颧 浊 砾 沓
廉 絮 瞻 眷 窃 搪 歧 窘 敝 祷
赋 蓑 瓤 镌 鳍 瀚 矗 屉 绽
敛 募 泵 筹 颠 怯 卿 弩 霹 泄
簌 迸 酥 遂 姹 履 携 撵 誊 掘

竭尽 冶炼 轻蔑 囫囵 憧 憬 谨慎 踉
跄 狰狞 吩咐 崎岖 簸箕 踌躇
勤勉 咀嚼 尴尬 巍峨 湍流 懊悔
嶙峋 咨询 紊乱 惆怅 晕厥 屏障 击
溃 凛冽 蔓延 憔悴 灌输 蹉跎 蕴
藏 熙攘 悬殊 涣散 慷慨 铸就
瞻仰 酝酿 偏僻 磅礴 魁梧 遮蔽
奴役 融洽 残喘 匪徒 恍然 陡峭
身躯 蕴含 静谧 烘烤 音韵 庞然
阻挠 毅然 恶劣 泥浆 岔道 真挚

Speeded Reading Comprehension Test

指导语：下面每道题有三个选项，请从中选出一个，这个选项最适合填进句子的括号里，把它的字母代号填在括号里。大家要快速阅读，在 15 分钟内完成尽可能多的题目。

练习：例如：题目为“ 小红提的意见很（ ），我们应当接受”，下面有三个选项：“A.明确　B.正确　D.精确”。答案为“B.”,你应该把“B”填在括号里。

测试：

1.今天我很高兴，妈妈给我买了一个我非常（　　）的文具盒。

A 漂亮　　　　B 丑陋　　　C 可怕

2.这样宏伟的建筑，（ ）只用十个月的时间就完成了。

A 忽然　　　B 竟然　　　C 猛然

3.我们班的班长陈水飞头脑（），办事很果断，大家都佩服他

A 迟钝　　　B 灵活　　　C 灵巧

4. 北方的夏天（ ）干旱，（　）大雨倾盆，这样的气候对养花来说不算很好。

A.不但 而且　　B.不仅......还　　c.不是......就是

5. 经过（　）的测量和仔细的推算，他提出了对这颗小行星运行轨道的见解。

A.精心　　　B精密　　　C 精巧

6. 这次登山活动，小明不出大伙所料（　　）得了第一名。

A 居然　B 果然　　C 忽然

7.他是一名长跑运动员，学校要举行长跑比赛，他（　　）要参加了。

A 忽然　　　　B 当然　　　　C 虽然

8.长期以来，它（　　）了晚上九点左右的温度和湿度，到了那时，便悄悄绽开淡雅的花蕾，向人们展示美丽的笑脸。

A 适宜　　　　B 适应　　　　C 适合

9.我们（　）做着，心中充满了憧憬和希望。

A 精心　B 精致　C 精力

10.我们向那房子跑去，（　）寻找我们的“幸福鸟”.

A 陆续　B 继续　C 连续

11.小纸船在下河中(　)向远方。

A 飘　B 漂　C 瞟

12 .五一节义务劳动时，天空突然下起大雨，同学们（　）躲雨，（　）干得更欢。

A.宁可不…… 也　B.不但不…… 反而　C.因为……所以……

13. （　)孔子已经很有学问了，（　）他还是虚心向他人学习。

A 虽然--------但是　B 不但--------而且　C 不是--------就是

14.(　)明天下雨，运动会(　)改天举行。

A 如果--------就　B 不是--------就是　C 因为--------所以

15.下课了,同学们(　)走出教室。

A 陆续　B 连续　C 继续

16. 老师告诉我们在写作时要有一定的(　)。

A 顺序　B 秩序　C 排序

17. （　)鸟的翅膀多么完美，（　）不凭借空气，它（　）永远不能飞到高空。

A.虽然......但是......也　B.不管......如杲......就....

C.尽管......如果.......就

18. 旧社会的农民辛苦了一年，才换来一点儿收成，卖米时又受到资本家（）的剥削，真没法活下去。

A 严酷　B 严峻　C 严格

19.在信中，凡卡诉说着自己猪狗不如的生活，告诉爷爷，自己的生活没（　）了。

A 希望　B 期望　C 瞭望

20.刺猬爱在户外地下找个洞穴，或者钻进大堆树叶下面(　)起来冬眠。

A 隐蔽　B 隐藏　C 隐含

21. 精致教育是一种为学生发展服务的高品质教育。实施精致教育，学校管理要精细，教师队伍要精良，课程设置要（　　），校园规划要精美。

A 精确　　B 精准　　C 精当

22. （　　）你下功夫学习，（　　）基础差些，（　　）能迎头赶上。
A.如果......那么......，.就...　B.只要......即使......也....
C.只要......不管……也....

23. 我们要（　）学校的一砖一瓦，要珍惜一分一秒的时光。
A .疼爱　　B.爱护　　C.热爱

24.“2006 年感动中国人物”之一的华益慰，从医 56 载，用自己的实际行动________了伟大的人格。

A 树立　　B 塑造　　C 雕塑

25. （　）我们已经学过了法律知识，（　）应该更自觉地遵守法律。

A 不是....就是....　　B 要么....要么 ....　　C 既然 ....就....

26. 我对他手里拿（　）的这本书不感兴趣，因为我已经看（　）三遍了。
A 过....了　　B 着....过　　C 了....　了

27. （ ）没有亲临其境，（ ）很难叫人相信这是真的。

A 虽然....但是.. ..　　B 只要....就....　　C　既然....但是....

28. （　）刻苦学习，（　）能不断提高学习成绩。

A 只有....才....　　B 不但....而且....　　C 因为....所以....

29. 奥运“祥云”火炬登顶珠峰，是中华民族挑战人类极限的一次壮举，是现代奥林匹克运动逾百年历史上的一道（　　），也是中国奉献给全世界的一大人类杰作。

A.风光　　B. 奇观　　C. 景色

30. 我们无法控制生命的长度，但我们可以靠增加它的宽度和高度来（　　）它的容积，使人生更加丰富多彩。

A.扩大　　　　B.　控制　　　C.减少

31.关爱，让人的心灵变得高尚。关爱增加了生命原野的厚度，提升了灵魂海拔的高度，(　　）了幸福人生的广度。

A.发展　　　　B .扩展　　　C.上升

32.周国平说，我不认为读书可以成为时尚，并且对一切成为时尚的读书持（　　）态度。读书属于个人的精神生活，必定是非常个人化的。可以成为时尚的不是读书，而是买书和谈书。譬如说，在媒体的影响下，某一时期有某一本书特别畅销，谈论它显得特时髦，插不上嘴显得特落伍。

A.迟疑　B.　怀疑　　　C.疑惑

33.　这里有一座高塔，攀登本身没有任何困难，而在每一级上，从塔上的嘹望孔望见的景致都足够(　　　　)　。每一件事物都是新的。无论近处或远处的事物都会使你依恋流连，但越往上走，攀登越困难，所以我们要学会坚持。

A.扣人心弦　　　B.望而生畏　　　C.赏心悦目

34.“神舟七号”航天团队同舟共济的团结精神，是“嫦娥”成功奔月的强大动力；他们求真务实的工作作风，让“嫦娥”的舞姿精准完美；他们“一切为了祖国，一切为了成功”的航天精神，永恒地（　　)在浩瀚无垠的太空。

A.　飘浮　　B.镌刻　　C.堆砌

35.　在我们赖以生存的绿色星球上，镶嵌着几块色彩斑斓的陆地，那是地球上的五大洲，在陆地中间充盈着辽阔的蓝色水域，那是地球的四大洋。这里有生命存在，生物活跃在多彩的生态系统中，它们(　）这个星球以绿色的情调和生命的意义。

A.呈献　　　　B.馈赠　　　C.赋予

36.踏着如雪的字，一路寻去，( )风寒扑面，( ) 想着那高标逸韵“临寒独自开”的梅，想着那“遥知不是雪，为有暗香来”的梅，( ) 似乎悟出“梅花香自苦寒来”的禅意。十年踏雪，踏雪寻梅。正是：十年踪迹十年心，赢得观众几份情。

A.虽.... 但.... 便 B.即使.... 也.... 就 C.虽然.... 只是.... 也