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Preschool predictors of dyslexia status in Chinese first graders with high or low familial risk

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Abstract The present 4-year longitudinal study examined preschool predictors of Grade 1 dyslexia status in a Chinese population in Hong Kong where children started learning to read at the age of three. Seventy-five and 39 Chinese children with high and low familial risk respectively were tested on Chinese word reading, oral language skills, morphological awareness, phonological skills, rapid naming, and print-related skills from age 4 to 6 and a standardized dyslexia test at age 7. Results showed that children of the high risk group performed significantly worse than the low risk group in Chinese literacy, phonological awareness, and orthographic skills at age 7. All the children with dyslexia had word reading difficulties in at least one preschool year. Results of the logistic regression showed that preschool verbal production, syllable deletion, and letter naming were the best predictors of dyslexia outcome at age 7. As in alphabetic languages, preschool oral language skills like verbal production, phonological skills, and print-related skills are the most significant predictors of children's later reading difficulties.

Keywords At-risk children · Chinese developmental dyslexia · Oral language · Phonological skills · Print-related skills

Introduction

There has been a growing interest of finding early predictors of dyslexia outcome in English-speaking children with familial risk and this would facilitate early identification and intervention (e.g., Pennington & Lefly, 2001; Scarborough, 1990; Snowling, Gallagher, & Frith, 2003). Such interest has extended to other alphabetic and nonalphabetic languages, such as Danish, Finnish, and Chinese (e.g.,

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Elbro, Borstrom, & Petersen, 1998; Lyytinen, Aro, & Holopainen, 2004; McBride-Chang et al., 2008, 2010; Ho, Leung, & Cheung, 2011b). Cross-linguistic investigations on reading disability of this kind are essential for building universal reading theories. Share (2008) has expressed a serious concern about the current reading research being over-reliant on studies conducted in English. This trend has posed questions regarding the universality of the reading theories being built predominantly on English-based research. For instance, given the highly irregular spelling-to-sound patterns in English words, diagnosis of dyslexia in English-speaking communities has been largely based on performance in word reading accuracy and ignoring the fluency aspect. In populations reading more transparent orthographies like Italian, German, Dutch, Finnish, and Hebrew, dyslexic individuals may attain high level of word reading accuracy but remain slow in decoding (e.g., Breznitz, 1997; Cossu, 1999; Lyytinen et al., 2004; Wimmer, 1993; Yap & van der Leij, 1993). Chinese is considered an opaque nonalphabetic writing system with low consistency between print and sound. It may not require cognitive skills the same as those for reading alphabetic regular or irregular orthographies. Chinese is a morphosyllabic language which may be a good testing case for examining whether the early predictors of later dyslexia status are the same as those in alphabetic languages. The present longitudinal study aimed at identifying significant preschool predictors of dyslexia outcome in Chinese first graders. The findings have important implications for the early identification of children with dyslexia in Chinese and may also inform effective early intervention. We will first outline below the major characteristics of the Chinese language.

Characteristics of the Chinese language

The basic graphic unit in Chinese is a character. There are about 3,000 Chinese characters in daily use in Mainland China (Foreign Languages Press Beijing, 1989) and about 4,500–4,900 frequently used characters in Taiwan (Liu, Chuang, & Wang, 1975) and Hong Kong (Cheung & Bauer, 2002). Each Chinese character represents a morpheme and is pronounced as a syllable with a fixed grouping of onset, rhyme, and tone. Chinese is a tonal language with a change in morpheme meaning resulted from a change in lexical tone. With a large number of morphemes represented by a limited number of syllables (around 1,300 in Mandarin Chinese), the problem of homophony in Chinese is extensive. Many syllables may have one or more homophones which carry different meanings (e.g., Packard, 2000). Given the relatively simple phonological structure of the Chinese language as compared with some alphabetic languages like English and French, awareness of syllables and tones, instead of phonemes, may be more important for learning to read Chinese (e.g., Li & Ho, 2011; McBride-Chang & Ho, 2000).

Although Chinese characters are visually complex, Chinese is not as logographic as people think. Only a small percentage of Chinese characters convey meaning by pictographic or ideographic representation (Hoosain, 1991). About 80–90 % of Chinese characters are ideophonetic compounds, each comprising a semantic and a phonetic component (Ho & Bryant, 1997a). There are different degrees of semantic and phonological regularity/consistency in Chinese characters. The predictive accuracy of the pronunciation of a compound character from its phonetic radical is about 26 % if lexical tone is taken into consideration (Chung & Leung, 2008; Fan, 1986; Shu, Chen, Anderson, Wu, & Xuan, 2003). Overall, semantic radicals are functionally more reliable than phonetic ones.

The orthographic rules in Chinese are rather complicated (e.g., having a large number of orthographic units and many homophones, different degrees of positional, semantic, and phonological regularities for radicals). Many of these rules are not formally taught in school but are acquired through repeated exposure to words in the sequence of character configuration knowledge, structural knowledge, radical information knowledge, positional knowledge, functional knowledge, and complete orthographic knowledge (Ho, Yau, & Au, 2003). It takes children nearly all their elementary school years to acquire a complete orthographic knowledge in Chinese. Alphabetic languages are usually orthographically less complex than Chinese. Orthographic skills are expected to be more important for learning to read Chinese than for reading alphabetic languages.

Unlike English, there is no inflectional system, such as subject-verb agreement and case marking in Chinese (Li & Thompson, 1981). Therefore, instead of using morphological transformation like inflection or derivation, word compounding or word order is used in Chinese to show tense, number, and degree. The majority of Chinese words are multi-morphemic. Many of these words are formed by lexical compounding rules (Packard, 2000), and Chinese compound words tend to be more transparent and productive than those of English. Given the extensiveness of homophony problem and the significance of word compounding in Chinese, morphological awareness is highly relevant for reading success and failure in Chinese and this may not be as important for reading English (e.g., McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003, McBride-Chang, Wagner, Muse, Chow, & Shu, 2005).

Family history as a risk predictor of dyslexia

Given the fact that developmental dyslexia is highly familial and heritable, children with family members having dyslexia are at high risk of literacy problems. Results of several longitudinal studies with children reading English, Finnish, or Dutch have shown that roughly between 30 and 60 % of the children at high family risk of dyslexia would themselves become dyslexic, but only 2–12 % of the low risk children are affected (e.g., Blomert & Willems, 2010; Boets et al., 2010; Elbro et al., 1998; Lyytinen et al., 2008; Pennington & Lefly, 2001; Snowling et al., 2003; Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010; van Bergen et al., 2011). For instance, Elbro et al. (1998) reported that 37 % of the children in their high familial risk group from Denmark became dyslexic while only 12 % were dyslexic in the control group. Effects of the familial risk seem to show up very early in life. For instance, the at-risk group in a Finnish sample, who spoke a regular alphabetic language, had differences in brain event-related potentials (ERPs) to speech and tone contrasts already at birth and 6 months of age (Leppänen, Pihko, Eklund, & Lyytinen, 1999, 2002; Guttorm, Leppänen, Richardson, & Lyytinen, 2001), differences in categorizing phonemic length at 6 months of age (Richardson, Leppänen, Leiwo, & Lyytinen, 2003), and differences in language skills like vocabulary and inflectional morphology at age 3.5 years as compared with the control group. These early speech and language processing differences were highly predictive of children's later reading performance (Lyytinen et al., 2004). Recent replication of the high incidence of dyslexia among those with familial risk was also found in children reading nonalphabetic Chinese. For instance, McBride Chang et al. (2010) have reported that 50 % of those with familial risk in their Chinese sample subsequently manifested dyslexia at age 7. Hence, familial risk could serve as an early predictor of later dyslexia outcome in alphabetic and nonalphebtic languages.

Early cognitive-linguistic skills as predictors of later reading outcome and dyslexia status

Apart from familial risk, some early cognitive-linguistic skills are also good predictors of later dyslexia outcome with an accuracy rate of around 75–85 % (Elbro et al., 1998; Pennington & Lefly, 2001; Scarborough, 1990, 1991). For instance, Pennington and Lefly (2001) performed a discriminant function analysis and showed that preschool letter-name knowledge, speech perception, phonological awareness, verbal STM, RAN, and parental reading history together correctly classified 69 % of the RD children and 76 % of the non-RD children in a Grade 2 English-speaking sample, with an overall classification rate of 75 %.

Regarding what early cognitive-linguistic skills could predict later reading outcome and dyslexia status, Hindson et al. (2005) and Lonigan (2006) have suggested candidates in three domains: (1) phonological processing skills, (2) oral language skills, and (3) print-related skills. The present study examines whether early skills in these three domains also predict later dyslexia status and reading outcome in Chinese.

Phonological processing skills

Research findings show that early phonological deficiency is the major predictor of later reading difficulties particularly in less transparent orthographies like English (e.g., Bradley & Bryant, 1978; Elbro et al., 1998; Hindson et al., 2005). Such phonological deficit interferes with children's ability to learn the alphabetic principle and hence decoding. Poor phonemic awareness has been shown to correlate with reading difficulties in some alphabetic languages (e.g., Bertelson & de Gelder, 1989; Castles & Coltheart, 2004; Holopainen, Ahonen, & Lyytinen, 2001; Shankweiler & Fowler, 2004). However, rapid naming retrieval and reading fluency, instead of phonemic awareness, become more important for learning to read in transparent orthographies (e.g., Hebrew script in its vowelized version) than in English (e.g., Geva, Wade-Woolley, & Shany, 1993) after the initial period of letter sound learning. Elbro et al. (1998) and others have suggested that poor-quality phonological representations may be the underlying cause of phonological deficits. They reported in their longitudinal study that distinctness of phonological representations and phoneme identification in kindergartners were significant and independent predictors of dyslexia, and measures of the quality of phonological representation also contributed significantly to predicting phoneme awareness in Grade 2 Danish children. Similarly, Scarborough (1990) found that at 30 months of age, children from RD English-speaking families were less accurate than the controls in their pronunciation of consonants, and phonological production abilities were strongly predictive of later reading status.

Phonological awareness deficits are not central to Chinese dyslexia at elementary grades (e.g., Grade 2 to Grade 4: Ho, Chan, Lee, Tsang, & Luan, 2004; Ho, Chan, Tsang, & Lee, 2002) or junior high schools (e.g., Chung, Ho, Chan, Tsang, & Lee, 2010). However, phonological awareness, especially syllabic awareness, has been found to be a significant predictor of Chinese reading acquisition in preschool children (e.g., Ho & Bryant, 1997b; McBride-Chang & Ho, 2000). This may be due to the fact that preschool children initially are sensitive to syllables and Chinese language is morphosyllablic, awareness to syllables may particularly help Chinese preschool children to match a morpheme to the corresponding character in their first years of learning. Since the Chinese character does not encode phonology analytically like letters in alphabetic scripts, phonemic awareness seems to be less important for reading in Chinese in higher grades.

Oral language skills

A number of researchers have suggested that the phonological deficit hypothesis does not offer a complete explanation for reading failure given the breadth of oral language problems associated with dyslexia (e.g., Gallagher, Frith, & Snowling, 2000; Nation & Snowling, 2004; Scarborough, 1991, 2005). Rather, dyslexia is seen as a “general verbal limitation” with changing manifestations over time, and is on a continuum with multi-componential language difficulties. Children who later became dyslexic were found to have an early history of less well developed vocabulary, verbal comprehension, and syntactic skills in addition to weaker phonological processing (Gallagher et al., 2000; Scarborough, 1990, 1991). Similarly, Van Alphen et al. (2004) reported that the at-risk Dutch children of four to 5 years old displayed a language and phonological profile resembling that associated with developmental language delay.

Apart from language skills like vocabulary, listening comprehension, and syntactic skills, the ability to attend to the smallest linguistic meaning unit, morphological awareness, has recently been found to be important for learning to read and morphological deficits contribute significantly to reading failure (e.g., Casalis, Cole, & Sopo, 2004; Deacon & Kirby, 2004). Deacon and Kirby (2004) have reported significant unique contributions of morphological awareness in Grade 2 children to their English reading comprehension 3 years later (but not their single word reading), even after controlling for the effects of intelligence, phonological awareness, and the autoregressor. Given the prominence of homophony and word compounding in Chinese, morphological awareness has been found to be more important in learning to read Chinese than English in second grade (McBride-Chang et al., 2005). Morphological awareness has been found to contribute to Chinese character reading in kindergartners and Grade 2 children after controlling for phonological awareness, speeded naming and vocabulary (McBride-Chang et al., 2003). The importance of morphological awareness applies to Chinese dyslexia as well. Fifth and sixth grade Chinese dyslexic children were found to perform significantly less well than age controls in morpheme production and judgment (Shu, McBride-Chang, Wu, & Liu, 2006).

Print-related and other skills

Apart from the language and phonological difficulties discussed above, Gallagher et al. (2000), Snowling et al. (2003), and Hulme, Goetz, Gooch, Adams, & Snowling (2007) also suggested that children at risk might have a specific verbal association learning difficulty in that they were slow in paired-associate learning, especially in learning visual-verbal associations. This could explain why these children experience difficulties in learning letter names and sounds. In Scarborough's (1998, 2005) meta-analysis, she reported that letter identification and concepts of print were the two most significant predictors of future reading scores. Difficulty in paired-associate learning may especially be the case for dyslexic readers of Chinese, a system with rather arbitrary associations between script and sound. Chow and Ho (2005) reported that the Chinese dyslexic elementary school children in their study learned some visual-verbal pairs even less efficiently than the younger reading-level controls.

Manis, Seidenberg, and Doi (1999) suggested that rapid naming deficit, another core deficit of developmental dyslexia, also reflects the children's difficulty of learning arbitrary associations. The findings of rapid naming deficit being the most dominant one in Chinese dyslexic school age children (Ho et al., 2004; Ho et al., 2002) and the second most dominant one in dyslexic adolescents (Chung et al., 2010) echo the significance of association learning skills in Chinese. It is interesting to note that phonological deficits alone in some language-impaired children do not lead to reading difficulties, they do only when accompanied by poor rapid naming skills (Bishop, McDonald, Bird, & Hayiou-Thomas, 2009). Rapid naming reflects not only the ability in learning arbitrary associations, but also the degree of automaticity in lexical retrieval. Given the fact that it takes a longer time (up to Grade 3) for children to learn the decoding rules in English but much faster for children learning to decode more regular orthographies, rapid naming has been found to associate stronger with reading in regular alphabetic orthographies such as German (Wimmer, 1993) and Dutch (de Jong & van der Leij, 2003) than that in English. Since there are no phonological decoding rules in Chinese, Chinese children may be fast at learning to recognize some initial words. However, the complicated orthographic structure of Chinese characters makes children difficult to discriminate orthographically similar characters when they learn more and more characters. Hence orthographic skill is another important print-related skill for learning to read Chinese.

Orthographic skill in Chinese refers to the skill in recognizing and processing the character structure, positional and functional aspects of the character components like radicals. Given the visual complexity of the graphic units and complicated orthographic rules in Chinese, it is expected that orthographic skills have a stronger role for learning to read Chinese than in reading alphabetic languages. It is therefore not surprising that orthographic deficit was found to be the second most dominant reading-related cognitive deficits in Chinese elementary school children with developmental dyslexia (Ho et al., 2002, 2004) and the most dominant one in Chinese dyslexic adolescents (Chung et al., 2010). Ho et al. (2004) have suggested that orthographic-related difficulties may be the crux of the problem in Chinese developmental dyslexia.

It is arguable that development of orthographic skills is much affected by reading experience. A child appears not able to develop orthographic skills without any exposure to printed words. However, orthographic skills are not the same as reading skills as the former may not involve much phonological processing and this is especially the case in Chinese (e.g., Ho et al., 2003). For instance, sensitivity to the legal character structure of Chinese (i.e., how stroke patterns could be combined to form a possible Chinese character) may be partly a result of reading experience but this skill does not require any knowledge about character pronunciation. We consider a lexical decision task (i.e., deciding whether a character/noncharacter looks like a legal character) an orthographic task that is less similar to a reading task. This task was used in the present study to measure orthographic skills.

Recent studies examining the early predictors of dyslexia in Chinese

Several recent studies have examined the cognitive profile and predictors of later reading difficulties in groups of Chinese preschoolers with familial risk of dyslexia. For instance, Ho et al. (2011b) have reported the findings of a 3-year longitudinal study that Chinese preschool children with familial risk who showed difficulties in word reading and spelling at age 6 do show a wide range of early deficits in phonological processing skills, rapid naming, oral language, morphological awareness, paired-associate learning, and print-related skills at ages 4 and 5. These children also displayed more behaviours indicative of reading difficulties in preschool years. Apart from family risk of dyslexia, low IQ, low SES, and poor home literacy support may constitute other risk factors for early reading difficulties. However, these children were too young to get formal assessment on dyslexia at the time of report. The present study is a follow-up of Ho et al.'s study (2011b) to report the prediction of preschool cognitive-linguistic skills for children's dyslexia status at age 7.

McBride-Chang et al. (2010) have reported another longitudinal study examining which cognitive skills at age 5 best discriminated children with and without dyslexia at age 7 in three groups of children (language delayed, with familial risk, and control). They reported that 50 % of those with familial risk and 62 % of those with early language delay subsequently manifested dyslexia. The at-risk and dyslexic children were also found to perform significantly worse than the control group in rapid naming and morphological awareness. With age 5 reading performance controlled, morphological awareness at age 5 was the only significant predictor of Chinese word reading at age 7, while rapid naming also predicted significantly age 7

1-min word reading. These findings concur with previous findings of the significance of morphological awareness and rapid naming in reading Chinese. However, caution has to be taken when interpreting these findings. First, the diagnostic definition of dyslexia in the study was not consistent to the local practice in Hong Kong where the sample was recruited. In order to be diagnosed as dyslexic in Hong Kong, apart from having a composite score of 7 or below (mean score is 10 and SD = 3) in the literacy subtests of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD, Ho et al., 2000), the child has to score 7 or below in one or more reading-related cognitive domain and has normal IQ. The purpose of these criteria was to exclude those with poor literacy performance because of low motivation or other environmental factors. This is an exclusionary-plus approach which has been adopted as the operational definition of dyslexia in the present study. In McBride-Chang et al.'s study, they only used the composite score of the three literacy subtests of the HKT-SpLD as the criterion for determining dyslexia without taking into consideration the children's cognitive scores. Therefore, some of the children in McBride-Chang et al.'s study might be poor readers or low achievers instead of dyslexic readers. In other words, the rate of real dyslexic cases might be lower than reported in their study. The second concern was that some important factors that were potential predictors of dyslexia (e.g., oral language, orthographic skills, paired-associate learning, and phonological memory) were not examined in their study but these skills were examined in the present study.

Onset and persistence of reading difficulties

Past research findings have shown that the reading difficulty of a substantial number of children with dyslexia persist through the elementary grades (e.g., Butler, Marsh, Sheppard, & Sheppard, 1985; Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; Jacobson, 1999), further into adolescence and even in adulthood (Bruck, 1992; Felton, Naylor, & Wood, 1990). For instance, 74 % of children who were found to be poor readers in third grade remained poor readers in ninth grade (Francis et al., 1996). Signs of reading difficulties may appear at preschool age and as mentioned earlier significant preschool predictors of later reading outcome in English include phonological awareness, phonological memory, alphabetic knowledge, RAN, oral language, print concept, and print knowledge (Eunice Kennedy Shriver National Institute of Child Health and Human Development, 2010). Apart from these early precursors, early failure in reading itself is also a strong predictor of later reading problems (Fletcher, Satz, & Morris, 1984; Jacobson, 1999). Since schools in many countries do not start formal reading instruction until the first grade, reading difficulties do not normally show up before first grade. Children in the present study however started learning to read formally in preschool from age three and hence gave us an opportunity to examine whether reading difficulties would show up as early as in preschool years and whether such difficulties persist to Grade 1. Such knowledge may help to decide how early effective identification could be.

Aims of the present study

The present paper reports the results of a 4-year longitudinal project comparing two groups of Chinese children, with high and low familial risk of dyslexia, from Kindergarten first year (K1) to Grade 1. Results of the first 3 years (i.e., K1 to K3) have been reported in Ho et al. (2011b); Ho and her colleagues (2011b) reported comparisons between the performance in preschool years of two groups with high and low familial risk and concluded that familial risk, low IQ, low SES, poor home literacy support may be some risk factors for early word reading and spelling difficulties in preschool years. Since the children were not formally assessed on dyslexia until Grade 1, prediction about dyslexia outcome with standardized measures was not examined in Ho et al. (2011b) but would do so in the present paper. The aims of the present study were to examine (1) differences between the high and low familial risk groups on literacy and reading-related cognitive skills in Grade 1; (2) the percentage of children with familial risk later become dyslexic; (3) the persistence of reading difficulties across 4 years from K1 to Grade 1; (4) preschool predictors of dyslexia status in Grade 1; and (5) preschool predictors of Chinese word reading in Grade 1. Preschool predictors included oral language, morphological awareness, phonological processing skills, rapid naming, paired-associate learning (PAL), and print-related skills. One unique contribution of this study is the examination of the predictive power of a comprehensive set of preschool cognitive-linguistic skills for later dyslexia status and reading outcome in Chinese. As mentioned earlier, the Ho et al. (2011b) did not include any measures for assessing dyslexia status and the role of some important cognitive-linguistic skills like oral language, orthographic skills, paired-associate learning, and phonological memory were not examined in McBride-Chang et al. (2010) study. Another unique contribution of the present study is the examination of the persistence of reading difficulties in Chinese from age four to seven. We are not aware of any study that has examined this issue in Chinese before. Apart from dyslexia, poor word reading, a milder form of reading difficulties, was also examined in this study. Details for determining the two conditions will be given later.

Method

Participants

The present paper reports the results of a 4-year longitudinal study with Chinese children aged from 4 to 7 years, i.e., from K1 to Grade 1 (Time 1 to Time 4) in Hong Kong, China. Children in Hong Kong learn to read from an early age. They start learning to read some single Chinese characters and two-character words from the age of three at K1. They normally learn around 200 Chinese characters by the end of K3 and are able to read short sentences. By the end of Grade 1, children in Hong Kong have learned around 500 new Chinese characters and read passages of around 80–100 characters. Although Pin-yin was introduced in some schools for teaching, many schools still use the look-and-say method for teaching Chinese characters in Hong Kong.

In this study, there were two groups of children, with high and low family risk of dyslexia. High family risk was defined as having at least one child or one parent with dyslexia, while low family risk was a lack of this characteristic. The recruitment procedures will only be reported briefly in the present paper and further details could be found in Ho et al. (2011b).

Invitation letters were sent to about 400 kindergartens in Hong Kong and questionnaires were collected from 1990 families with K1 children. Each questionnaire included items on demographic information, learning history, and family history. There are standard diagnostic procedures and standardized assessment tools for the identification of children with dyslexia in Hong Kong, but no such procedures or tools are available for diagnosis of Chinese adults with dyslexia. Identification of affected child members relied on formal diagnosis while that of affected adult members relied on multiple measures including self-report, the standardized Hong Kong Reading and Writing Behaviour Checklist for Adults (Ho et al., 2007a, Ho, Leung, Cheung, Leung, & Chou, 2007b), and performance on three literacy tests (Chinese word reading, 1-min word reading, and word dictation). Parents who reported having reading difficulties (according to Elbro et al.'s 3 questions in 1998) or those scoring above the cutoff point of the Hong Kong Reading and Writing Behaviour Checklist for Adults (Ho et al., 2007a, b), a standardized tool with local norm for screening those at risk with dyslexia, were invited to individual assessment. Parents with normal intelligence, at least secondary school level of education, and at least 1 standard deviation below the norm mean in at least 2 of the literacy tests were classified as dyslexic.

More children with high familial risk than low familial risk were recruited as we would like to have enough number of children with dyslexia at Time 4 for comparison. At the beginning of the project, 86 (mean age = 4.20 years, SD = 0.32) and 45 (mean age = 4.25 years, SD = 0.38) K1 children were recruited from the community into the high risk and low risk groups respectively and tested at Time 1. In Grade 1, 75 and 39 children remained in the two groups respectively. The attrition rates for the two groups were comparable over time with 7, 5, and 1 % for the high risk group, and 4, 5, and 5 % for the low risk group from Time 1 to Time 4 respectively. Children in the high risk and low risk groups were 7.12 years (SD = 0.38) and 7.19 years (SD = 0.40) on average respectively when they were tested at Time 4. Table 1 shows the background details of the two groups in Grade 1. The two groups were similar on age and IQ. The low risk group had an overall higher family income than the high risk group [χ^2 (6) = 16.3, $p < 0.05$]. In our questionnaire, there were seven categories of family income (from "$5,000 or below" to "$30,001 or above"). For simplicity of presentation, the data were regrouped into two categories. Differences in family income will be controlled in later analyses.

Table 1 Characteristics of the two groups of participants

Characteristic	High risk group (n = 75)	Low risk group (n = 39)	Group comparison
Age in years at Time 4 (Grade 1)	7.12 (0.38)	7.19 (0.40)	HI = LO
IQ (Raven's)	108.09 (13.09)	112.38 (10.57)	HI = LO
Family income (HKD per month)	60 % < $20,001	24 % < $20,001	HI < LO
	40 % > $20,000	76 % > $20,000	

Four children, two from each group, did not have family income information

HI high risk group, *LO* low risk group

Materials and procedures

A number of cognitive-linguistic measures and Chinese word reading were administered in K1 to K3 (i.e., Time 1 to Time 3) and the cognitive-linguistic measures were used as predictors of outcome status in Grade 1 (i.e., Time 4). To ensure good discriminative power of the tasks for the children at different ages, the task items were developed considering different grade level difficulties. Detailed procedures of these measures could be found in Ho et al. (2011b). The Hong Kong Test of Specific Learning Difficulties in Reading and Writing for Primary School Students-Second Edition [HKT-P(II)] (Ho et al., 2007a, b) was used to assess which children became dyslexic in Grade 1. Table 2 shows a list of all the measures administered in this study at different time points.

Oral language (Time 1 to Time 3)

At Time 1, a picture vocabulary test and a verbal comprehension test were administered. For the former test, the K1 children were asked to point to the correct picture from four picture-choices each for 70 orally presented vocabularies (65 from the Hong Kong Cantonese Receptive Vocabulary Test, Lee, Lee, & Cheung, 1996, and 5 were developed by the Ho et al., 2011b). The alpha coefficient for reliability was 0.76. Subtests 8 and 9 of the Verbal Comprehension Scale A of the Chinese version of Reynell Developmental Language Scale (Reynell & Huntley, 1985) were used to test verbal comprehension at the sentence level. The children were asked some questions and they responded by manipulating or pointing to some objects. Subtest 8 measured children's ability in understanding attributes like colour, size, position and negatives beyond nouns and verbs (e.g., "Put three short pens in the box"). Subtest 9 required the assimilation of different verbal concepts including nouns, verbs and other parts of speech, together in one sentence (e.g., "Apart from the black pig, put all the animals in the box"). The alpha coefficient was 0.82.

At Time 2, Subtests 9 and 10 of the Reynell Scale were given to the K2 children. Subtest 10 was more demanding on verbal reasoning and its ideational content went beyond visible information. The child was presented four dolls (Siu-ming, Siu-fun, mother, and baby). In one question, the child was asked "which person does not go

Table 2 All the measures administered in the study at different time points

Measures administered	Time 1 (K1)	Time 2 (K2)	Time 3 (K3)	Time 4 (G1)
Oral language				
Picture vocabulary	√			
Oral vocabulary			√	
Verbal comprehension	√	√		
Verbal expression			√	
Morphological awareness				
Morphological construction			√	
Phonological processing skills				
Syllable deletion		√	√	
Syllable repetition		√	√	
Rapid naming				
Picture naming	√	√	√	
Digit naming		√	√	
Print-related skills				
Letter naming	√			
Lexical decision			√	
Title recognition			√	
Paired-associate learning		√	√	
Chinese word reading	√	√	√	
Hong Kong test of specific learning difficulties in reading and writing				√

to school now but will do so later?" The child was expected to point to the baby doll. The alpha coefficient was 0.62 for the test at Time 2.

At Time 3, an oral vocabulary task and a discourse level verbal expression test were administered. The children were asked to define 12 Chinese words of familiar and concrete objects/places orally to test their proficiency of spoken vocabulary. Two marks were given if a word was fully defined with the main functions or characteristics of the referent concepts. One mark was given if general understanding of the word was shown but ambiguous explanations were given. The alpha coefficient was 0.72 and the inter-rater reliability was 0.98. In the subtest of the Expressive Language Scale of the Reynell Scale, the children were asked to describe what they saw in two line-drawing pictures ("dinner preparation" and "playing in a park"). Each picture carried a maximum of 8 marks according to the scoring criteria set out in the manual. Two marks were given for description of the concepts of the whole picture (e.g., "It's dinner time"); a maximum of four marks for the number of connections between all the ideas in any one sentence (a four mark example is "The children are helping their father clean the shed"); and two marks for sentences relevant to the picture in addition to the sentence counted for Connected Ideas. The inter-rater reliability was 0.92.

Morphological awareness (Time 3)

A morphological construction task was developed to measure the children's ability to construct new compound words. In constructing new compound words, the child was required to use appropriate morphemes in an acceptable order to form new words according to the compounding rules. Hence this was a test of children's knowledge of morphemes and compounding rules. An example was: "If we call a piece of paper that is in white 'white paper', what should we call a piece of paper that is in red?" The correct answer would be "red paper". There were 15 items in this task and the alpha coefficient was 0.77.

Phonological processing skills (Time 2 to Time 3)

A syllable deletion task and a syllable repetition task were given both at Time 2 and Time 3 to measure phonological awareness and phonological memory respectively.

Syllable deletion There were 24 three-syllable items and 18 four-syllable items for the K2 and K3 measures respectively. In each item, the children were first asked to repeat aloud a three- or four-syllable word. They were then instructed to say the item again by omitting one syllable (either at the beginning, end, or middle of the string). The alpha coefficients were 0.85 and 0.91 for Time 2 and Time 3 respectively.

Syllable repetition The present syllable repetition task was a modified version of the Word Repetition Subtest of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD) (Ho et al., 2000). Legal Chinese syllables were combined to form two- to six-syllable-strings for K2 children and four- to six-syllable-strings for K3 children. The children were asked to repeat orally each syllable-string in the order presented after they had heard a bell signal at the end of each string. As in the HKT-SpLD, a partial scoring method was employed. A correct utterance of a syllable yielded one mark and each correct sequence of two syllables also yielded one mark. The maximum score of this task was 63 for both the K2 and K3 measures. The alpha coefficients were 0.74 and 0.73 at Time 2 and Time 3, respectively.

Rapid naming (Time 1 to Time 3)

Two rapid naming tasks (pictures of objects and digits) were used in this study. Only the picture naming task was given at Time 1, and both the picture naming and digit naming tasks were administered at Time 2 and Time 3. In the rapid picture naming task, five color pictures of common objects (sun, apple, butterfly, aeroplane, and fan), each of which with a two-syllable name in Chinese, were printed three times (for K1), four times (for K2), or five times (for K3) in random orders on a white cardboard in a 5×3, 5×4 or 5×5 matrix. For the rapid digit naming task, five digits (2, 4, 5, 7 and 9) were printed in random orders on a white cardboard in a

5×4 (for K2) or 5×6 (for K3) matrix. For all the tasks, the children were asked to name each list as quickly and accurately as possible twice. Average latency across the two trials was computed. The reliabilities across the two trials of rapid picture naming were 0.67, 0.66, and 0.73 for Time 1 to Time 3 respectively, whereas the reliabilities of rapid digit naming were 0.94 and 0.81 for Time 2 and Time 3 respectively.

Print-related skills (Time 1 and Time 3)

Letter naming English letter naming was used as a measure of early print-related skill of the children at K1. Most of the children in Hong Kong learn English letters from the beginning of kindergarten. The 26 English letters were printed in capital and arranged in a fixed random order on a white cardboard. The children were asked to name each letter accordingly. The alpha coefficient was 0.96.

Lexical decision The Lexical Decision subtest of the HKT-SpLD was used to assess the children's knowledge of Chinese character structure at K3. There were 30 left–right structured rare Chinese characters and 30 noncharacters. In each noncharacter, either the left component, or the right component, or both components was/were placed in its/their illegal position(s). The children were required to cross out all the noncharacters.

Title recognition The title recognition task was used as a proxy of children's print exposure. This task was constructed in ways similar to the print exposure measure in Cunningham and Stanovich's (1990) study and the book exposure checklist in Senechal et al.'s (1996) study. The K3 children were given a list of 15 real and 15 fake titles of popular Chinese story books for kindergartners. Foils were included to check whether the children's responses were above chance level. The book titles were read to the children to prevent confounding of reading ability. The children were asked to indicate which were real or fake by ticking or crossing the titles respectively. Each correctly identified real or fake title scored one mark, with a total of 30 marks. The alpha coefficient was 0.78.

Paired-associate learning (Time 2 to Time 3)

A visual-verbal paired-associate learning (PAL) task was administered at Time 2 and Time 3 to test the children's ability to learn the arbitrary associations between visual and verbal stimuli. In this task, the children were asked to learn the associations of five and six pairs of abstract figures and their names (in single Cantonese syllables) at Time 2 and Time 3, respectively. There were two learning and four testing trials. Corrective feedback was given to the children after their response to each item. Total scores were 20 and 24 for Time 2 and Time 3 respectively. The alpha coefficients were 0.87 and 0.86 for Time 2 and Time 3 respectively.

Chinese word reading (Time 1 to Time 3)

Test materials of the reading tasks were selected based on two sets of the most popular Chinese reading textbooks for kindergarten children in Hong Kong and the results of our pilot studies. Thirty and 35 Chinese single-character words, and 40 two-character words were selected to test the children's Chinese reading skills at K1, K2, and K3 respectively. The children were asked to read the words aloud one by one. The alpha coefficients were 0.94, 0.96, and 0.97 for Time 1 to Time 3 respectively.

Dyslexia test (Time 4)

The HKT-P(II) is a standardized test developed to diagnose developmental dyslexia in Hong Kong primary school children. There are 12 subtests in the HKT-P(II), which are grouped into four areas: literacy, phonological skills, rapid naming, and orthographic skills. Apart from having normal intelligence (with IQ 80 or above), diagnosis of developmental dyslexia in Hong Kong (and in the present study) is defined as being at least 1 SD below the age means in both literacy composite score and at least one cognitive composite score in the HKT-P(II). The practice of diagnosing children with dyslexia at the end of Grade 1 was considered appropriate in Hong Kong as the children started learning to read from age three and already had 4 years of reading experience by age 7. All the following measures were administered at Time 4.

Literacy The three literacy tests are Chinese Word Reading, 1-min Reading, and Chinese Word Dictation. In the Chinese Word Reading test, children were requested to read aloud 150 Chinese two-character words graded in levels of difficulty. The test was discontinued when the child failed to read 15 words consecutively. For the 1-min Reading test, children were asked to read aloud each of the 90 simple Chinese two-character words as quickly and as accurately as possible within 1 min. For the Chinese Word Dictation test, children were asked to write for dictation 48 Chinese two-character words. The test was discontinued when the child failed to write correctly eight consecutive words.

Phonological awareness The two phonological awareness tests are Rhyme Detection and Onset Detection. In each of the 18 trials of Rhyme Detection and each of the 15 trials of Onset Detection, three Chinese syllables (names of common objects) were presented to children using a CD player together with pictures of these objects to ease memory load. Children were asked to indicate which two among the three syllables sounded similar.

Phonological memory In the three phonological memory tests, Word Repetition I (15 trials) and Nonword Repetition (14 trials) were used to test children's phonological short-term memory, whereas Word Repetition II (15 trials) was used to test children's phonological working memory. The stimuli were presented auditory with a CD player. Individual syllables in the two Word Repetition tests were real Chinese morphemes, whereas those in the Nonword Repetition test were phonetically legal syllables in Cantonese but were only nonsense syllables. The syllables were presented at the rate of two syllables per second in the Word Repetition I and Nonword Repetition tests, and one syllable per second in Word Repetition II test where the slower presentation would allow mental rehearsal of the syllables, thus providing a measure of working memory. In each item of the tasks, the children were asked to repeat orally the syllables in the presented order.

Rapid naming In this Rapid Digit Naming test, five digits (2, 4, 6, 7, and 9) arranged in eight rows of five digits each on a piece of A4-size card were repeated eight times in random order. Children were asked to name the 40 digits as fast and as accurately as possible from left to right and row by row. Children were asked to name the list twice.

Orthographic skills The three orthographic tests are Left/Right Reversal, Lexical Decision, and Radical Position. Left/Right Reversal was used to assess children's ability to identify the correct orientation of certain highly frequent orthographic units. In the 70 simple Chinese characters and numbers, half of which were left–right reversed, children were asked to cross out all items with an incorrect orientation. Lexical Decision was used to assess children's knowledge of Chinese character structure. There were 30 rare characters and the 30 noncharacters with their radicals placed in illegal positions, children were requested to cross out all noncharacters. Radical Position was used to assess children's knowledge of positional regularity of Chinese radicals. In responding to the 20 semantic and phonetic radicals in the test, children were asked to indicate from the four options (left, right, top, and bottom) the legal position of each radical.

General intelligence (Time 4)

The short form of the Raven's Standard Progressive Matrices, a standardized test of nonverbal intelligence with local norms, was administered at Time 4. There were three sets of 12 items each in the test. Each item consisted of a target visual matrix with one missing part. The children were asked to select, from six to eight alternatives, the part that best completed the matrix.

Results

Table 3 shows the estimated marginal means and standard errors of the measures from Time 1 (K1) to Time 3 (K3) for the High and low risk groups after controlling for differences in family income. It was found that the high risk group performed significantly less well than the low risk group in picture vocabulary at Time 1, verbal expression, lexical decision, and title recognition at Time 3 (all Fs > 4.58, all ps < 0.05). This suggested that the High and Low risk groups already differed in oral language and print-related skills at preschool years.

Table 3 Estimated marginal means and standard errors of the measures from Time 1 to Time 3 for the two groups of participants after controlling for differences in family income

Measures	Time 1 (K1)		Time 2 (K2)		Time 3 (K3)	
	High risk group	Low risk group	High risk group	Low risk group	High risk group	Low risk group
Picture vocabulary	53.53 (0.76)*	56.43 (1.08)*				
Oral vocabulary					17.52 (0.44)	18.01 (0.64)
Verbal comprehension	15.53 (0.48)	17.08 (0.69)	13.71 (0.36)	14.57 (0.51)		
Verbal expression					11.29 (0.26)**	12.57 (0.37)**
Morpho. construction					21.96 (0.64)	23.81 (0.92)
Syllable deletion			12.57 (0.77)	15.00 (1.10)	11.35 (0.55)	13.16 (0.79)
Syllable repetition			40.06 (1.29)	42.86 (1.84)	27.46 (1.42)	30.12 (2.04)
RAN picture (s)	24.71 (0.85)	23.76 (1.20)	26.85 (0.77)	25.93 (1.10)	30.15 (0.86)	28.43 (1.24)
RAN digit (s)			17.65 (0.92)	16.76 (1.31)	20.33 (0.69)	18.79 (0.99)
Letter naming	18.23 (0.94)	20.01 (1.33)				
Lexical decision					40.06 (0.88)*	44.00 (1.26)*
Title recognition					20.18 (0.56)**	22.96 (0.81)**
PAL			9.56 (0.53)	9.47 (0.76)	12.33 (0.71)	13.89 (1.01)
Chinese word reading	7.16 (0.82)	6.23 (1.16)	15.65 (1.29)	14.84 (1.83)	28.71 (1.31)	29.15 (1.88)

* $p < 0.05$; ** $p < 0.01$

The main focus of the present paper was to examine differences between the High and low risk groups on literacy and reading-related cognitive skills in Grade 1, the percentage of children with familial risk later become dyslexic, the persistence of reading difficulties across 4 years from K1 to Grade 1, and the preschool predictors of dyslexia status and reading outcome in Grade 1.

Group comparisons on cognitive-linguistic skills at Time 4

Table 4 shows the estimated marginal means and standard deviations (SDs) of the composite scores of HKT-P(II) at Time 4 for the high risk and low risk groups. Results of ANCOVAs (controlling for family income) showed that in general the high risk group performed significantly worse than the low risk group in Chinese literacy, phonological awareness, and orthographic skills (all Fs > 3.14, all ps < 0.05) at Grade 1. The group difference on rapid naming was marginally significant [$F(2, 107) = 2.85$, $p = 0.06$].

Group comparisons on the percentages of children with dyslexia or poor word reading at Time 4

Table 5 shows the percentages of children in the two groups being classified as dyslexic versus non-dyslexic readers, and poor word readers versus average word readers. Dyslexic were those who were at least 1 SD below the age means in both

Table 4 Estimated marginal means and standard errors of the composite scores of the various domains at Time 4 (Grade 1) for the two groups of participants after controlling for differences in family income

Domain	High risk group (n = 73)	Low risk group (n = 37)	Group comparison F(2, 107)
Chinese literacy	10.25 (0.35)	10.42 (0.50)	4.00*
Phonological awareness	10.42 (0.25)	11.91 (0.36)	8.63***
Phonological memory	10.77 (0.91)	10.35 (1.30)	0.04
Rapid naming	10.07 (0.37)	11.31 (0.53)	2.85#
Orthographic skills	10.86 (0.22)	11.21 (0.32)	3.15*

The estimated marginal means were corrected for differences in family income

* $p < 0.05$; *** $p < 0.001$; # $p = 0.06$. Four children, two from each group, did not have family income information

Table 5 Proportions of children with or without dyslexia and classification of average or poor reading in the two groups

Outcome at Time 4	High risk group	Low risk group
Non-dyslexic readers	69 (92 %)	36 (92.3 %)
Dyslexic readers	6 (8 %)	3 (7.7 %)
Total	75 (100 %)	39 (100 %)
Average word readers	62 (82.7 %)	35 (89.7 %)
Poor word readers	13 (17.3 %)	4 (10.3 %)
Total	75 (100 %)	39 (100 %)

literacy composite score and at least one cognitive composite score in the HKT-P(II). Poor word readers were those who were at least 1 SD below the age means in the Chinese word reading subtest of the HKT-P(II). It was found that only 8 % (6 out of 75) and 7.7 % (3 out of 39) of children were classified as dyslexic readers in the High and low risk group respectively. Using a more lenient classification, there were 17.3 % (13 out of 75) and 10.3 % (4 out of 39) of poor word readers in the High and low risk Group respectively. Group differences on both classification results were statistically not significant.

Persistence of reading difficulties from Time 1 to Time 4

Preschool word reading difficulty was defined as having a Z score below −1 in the Chinese word reading test administered at Time 1 to Time 3. It was found that all the dyslexic readers had word reading difficulties in at least one preschool year, while 67 % of them had difficulties in two or three preschool years. Similarly, 94 % of the poor word readers had word reading difficulties in at least one preschool year, and 65 % had difficulties in two or three preschool years. Reading difficulties seem to be very persistent from an early age.

Logistic regression analyses

Logistic regression analyses were carried out to examine the preschool predictors of dyslexia status in Grade 1. As in Elbro et al.'s (1998) procedures, the first step is to locate significant predictors of dyslexia outcome in each group of predictors, namely background variables, oral language skills, phonological processing skills, and print-related skills. Using Wald's forward stepwise method, seven significant predictors were identified. For the background predictors, when age, IQ, and family income were entered into a logistic regression analysis, only IQ at Time 4 remained statistically significant ($\chi^2 = 7.35$, $p < 0.01$). For the language-related predictors, when all language and morphological awareness measures were entered into the analysis, Reynell's verbal comprehension at Time 1 and Reynell's verbal expression at Time 3 were found to be significant predictors ($\chi^2 = 17.56$, $p < 0.001$). For the phonological predictors, when phonological awareness, phonological memory, and rapid naming measures were entered into the analysis, syllable deletion at Time 3 and rapid naming of digits at Time 3 were found to be the significant predictors ($\chi^2 = 26.51$, $p < 0.001$). For print-related skills, letter naming, lexical decision, title recognition, and PAL were entered into the analysis, letter naming at Time 1 and lexical decision at Time 3 were found to be significant predictors ($\chi^2 = 36.84$, $p < 0.001$).

To develop a model of unique predictors of dyslexia outcome across all groups of predictors, the seven significant predictors were entered simultaneously in a final logistic regression analysis with Wald's forward stepwise selection. It was found that only three predictors were significant in this final model, namely verbal expression at Time 3 (an oral language predictor), syllable deletion at Time 3 (a phonological predictor), and letter naming at Time 1 (a print-related predictor) ($\chi^2 = 42.68$, $p < 0.001$). Table 6 shows the prediction accuracy of dyslexia

Table 6 Prediction of dyslexia outcome based on the results of logistic regression analyses

	Predicted normal	Predicted dyslexic	Correct prediction rate (%)
Observed normal	102	1	99.0
Observed dyslexic	2	7	77.8
Overall prediction rate			97.3

outcome at Time 4 based on the results of this final logistic regression analysis. With the three predictors, the overall correct prediction rate was 97.3 %, the specificity rate was 99 %, and the sensitivity rate was 77.8 %.

Multiple regression analyses

Apart from predicting dyslexia outcome which based on assessment of both literacy and cognitive skills, we would also like to examine the predictors of Chinese word reading, a core measure of general reading performance. Since all the K3 cognitive-linguistic measures correlated significantly with the Grade 1 Chinese word reading (all *r*s > 0.24, all *p*s < 0.01), all the K3 measures were entered as predictors for Grade 1 Chinese word reading in the regression analysis with the forward selection method. Age, IQ, family income, and family risk were first entered in the regression model as controls. Table 7 shows both results with or without control of the auto-regressive effect of Chinese word reading at K3. It was found that rapid naming, morphological awareness, and paired-associate learning were significant predictors when Chinese word reading at K3 was not controlled (total $R^2 = 0.41$) but only paired-associate learning remained to be significant when the auto-regressive effect of Chinese word reading was controlled (total $R^2 = 0.71$).

Table 7 Results of the final step of multiple regression with cognitive-linguistic skills at Time 3 predicting chinese word reading at Time 4 for the whole sample (N = 114)

Predictors at Time 3	Chinese word reading at Time 4 (not controlling Time 3 reading)			Chinese word reading at Time 4 (controlling Time 3 reading)		
	B	*SE B*	β	*B*	*SE B*	β
IQ	0.81	0.44	0.17	0.17	0.31	0.04
Age	−0.58	0.59	−0.08	−0.58	0.41	−0.08
Family income	3.29	1.27	0.21*	1.59	0.90	0.10
Family risk	−7.53	5.03	−0.13	−2.11	3.51	−0.04
Chinese word reading at Time 3	–	–	–	2.01	0.16	0.77***
Rapid naming	−1.64	0.41	−0.33***			
Morphological awareness	1.19	0.48	0.22*			
Paired associate learning	0.95	0.42	0.20*	0.66	0.29	0.14*
R^2		0.41			0.71	
F		9.97***			41.34***	

* $p < 0.05$; *** $p < 0.001$

Discussion

To summarize, the major aim of the present study was to examine the preschool predictors of Grade 1 dyslexia status in Chinese. The present findings showed that children of the high risk group generally performed significantly worse than the low risk group in Chinese literacy, phonological awareness, and orthographic skills in Grade 1. However, not significantly more high risk children (8 %) than low risk children (7.7 %) became dyslexic in Grade 1. Using a more lenient classification, there were slightly more poor word readers in the high risk group (17.3 %) than in the low risk group (10.3 %). All the dyslexic readers and 94 % of the poor word readers had word reading difficulties in at least one preschool year. Results of the logistic regression showed that verbal expression at Time 3, syllable deletion at Time 3, and letter naming at Time 1 were significant predictors of dyslexia outcome at Time 4 (Grade 1) with an overall correct prediction rate of 97.3 %. As for prediction of Chinese word reading at Time 4, phonological awareness, rapid naming, and morphological awareness at Time 3 were found to be significant predictors but they failed to remain significant when the auto-regressive effect of Chinese word reading was controlled. Implications of these findings will be discussed in details in the following sections.

Reading outcomes of children with familial risk

The present findings suggest that in general children with familial risk tend to have more literacy-related difficulties, especially phonological awareness, than children from low risk families in Grade 1 when differences in SES (i.e., family income) were taken into consideration. Past studies in alphabetic languages have shown that roughly between 30 and 60 % of the children at high family risk of dyslexia would themselves become dyslexic, but only 2–12 % of the low risk children are affected (e.g., Blomert & Willems, 2010; Boets et al., 2010; Elbro et al., 1998; Lyytinen et al., 2008; Pennington & Lefly, 2001; Snowling et al., 2003; Torppa et al., 2010; van Bergen et al., 2011). However, only 8 % of the high risk children in the present study met the diagnostic criteria of dyslexia and another 9 % were classified as poor word readers. This seemingly contradictory finding implies that many children with familial risk may have some difficulties in reading-related skills even though they may not meet the classification of dyslexia. This suggestion is consistent with the continuity view of Gallagher et al. (2000) and Pennington and Lefly (2001). As an empirical support to this continuity hypothesis, Elbro et al. (1998) reported that nondyslexic children in dyslexic families had deficits relative to controls on morphological awareness and articulation, but not in other cognitive areas such as letter knowledge or phoneme awareness. Snowling et al. (2003) also reported that unaffected children in high-risk families also showed mild but significant impairments of verbal short-term memory, phonological awareness, letter knowledge, and nonword decoding. In the present study, though not having more children meeting the dyslexia diagnostic criteria, Chinese children in high-risk families tend to be relatively weak in oral language skills and orthographic skills in preschool years, and in phonological awareness and orthographic skills in Grade 1. This suggests that children with familial risk tend to be weaker than ordinary children on some language and reading-related skills, which in turn may adversely affect their learning to read in later grades (e.g., Elbro et al., 1998; Ho et al., 2011b). It appears that the family risk of dyslexia may be continuous. Early intervention may benefit those at risk children in preschool years as they may develop mild to severe forms of reading-related difficulties in elementary grades.

One unexpected finding is that the percentage of at-risk children later become dyslexic was much lower than expected. For instance, the similar percentage of dyslexia outcome was 50 % in McBride-Chang et al.'s (2010) study but it was 8 % in the present study. As mentioned in the introduction of this paper, the former study only used literacy performance as the criterion for defining dyslexia but the present study used both literacy and reading-related cognitive performance for diagnosis as in line with the local practice. Apart from this, in the present study, the children were recruited from the community with diverse background and most children (and their siblings) showing no signs of difficulty at the beginning of this study. On the other hand, children in McBride-Chang's study were recruited from families attending Child Assessment Centers and siblings of the participants were seeking professional support from the Centers. It was likely that these clinic-based children had potentially more problems than those from the community. Another possibility for the contradictory finding was that around 75 % of those with familial risk in the present study were having affected parents while all of those with familial risk in McBride-Chang's study were having affected siblings. Since diagnostic criteria for Chinese children and adults with dyslexia are not the same, the two studies might have included families of different degree of risk factors.

How the affected parents were recruited may be another possible reason for the low incidence rate of dyslexia in the present child sample. Services for the identification of and support for dyslexia is relatively new (around 20 years or less) in Hong Kong as compared with well-established systems in western countries like UK and US. Since there was no standardized assessment tool for identifying adult dyslexia in Hong Kong, the present study used a standardized adult behavior checklist and three experimental literacy tasks to identify affected parents. This method might have recruited some families with reading difficulties more a result of environmental than genetic factors. This speculation is partially supported by the fact that the high risk group had lower SES than the low risk group and likely had relatively less educational opportunities. This might to some extent affect the home literacy environment of the children as reflected by the lower title recognition score, a measure of print exposure, of the high risk group. To examine whether Chinese adult dyslexia is more environmentally driven than child dyslexia or in alphabetic orthographies, future studies may recruit those affected parents who have been diagnosed with the standardized tool in their childhood. These studies would be possible in Hong Kong when the affected children or adolescents grow up to become parents some 5–10 years later.

Preschool predictors of dyslexia status and reading outcomes

In the past decades, many studies have examined the early predictors of later reading outcomes or difficulties in alphabetic languages (e.g., Elbro et al., 1998;

Hindson et al., 2005; Pennington & Lefly, 2001; Scarborough, 1990, 1991; Snowling et al., 2003). However, relatively few examined the specific preschool prediction of later dyslexia status. Among these few studies, Elbro et al. (1998) in Denmark, for instance, has identified five strong predictors (letter naming, initial phoneme deletion, phoneme identification, pronunciation accuracy, and distinctness of phonological representations) in kindergarten to be significant predictors of dyslexia in Grade 2 with an overall prediction rate of 84 %. Findings of the present study show that preschool oral language skills (measured by a verbal expression task), phonological awareness (measured by a syllable deletion task), and print-related skills (measured by a letter naming task) together correctly predicted 97 % of children's dyslexia status in Grade 1. This finding is consistent with the suggestion of Hindson et al. (2005) and Lonigan (2006) that the core areas for at-risk preschool children showing deficits are oral language skills, phonological skills, and print-related skills as reviewed in the introduction of this paper. The phonological deficit model (e.g., Elbro et al., 1998; Scarborough, 1990) and the verbal deficit model (e.g., Gallagher et al., 2000; Nation & Snowling, 2004) have received much attention and support in the past in alphabetic languages. However, print-related deficits received relatively less attention. Letter identification has been found to be the most significant predictor of future reading in alphabetic languages (see Scarborough's meta-analysis, 1998, 2005). Interestingly, letter naming in K1 was found to be a strong predictor of dyslexia status in Grade 1 in the present study with nonalphabetic readers. This is not the single study showing the predictive power of letter naming in Chinese. McBride-Chang and Ho (2000) also reported a significant unique contribution of letter naming to Chinese character recognition in the same kindergarten year. We suggest that letter naming may have captured a kind of long-term learning skill that involves learning arbitrary associations of visual symbols and verbal names that similar to many ways of learning to recognize Chinese characters. The "look and say" method further makes such kind of learning skill particularly important in Hong Kong Chinese children's reading acquisition.

As for preschool prediction of Chinese word reading, a core measure of general reading performance, McBride-Chang et al. (2010) have reported that morphological awareness was the only significant predictor at age 5 for predicting Chinese word reading at age 7, either with or without the autoregressive effect of word reading being controlled. In the present study, rapid naming, morphological awareness, and paired-associate learning at age 6 were found to be significant predictors of Chinese word reading at age 7 before the autoregressor was controlled but only paired-associate learning remained significant when Chinese word reading at age 6 was controlled. Inclusion of different measures in the two studies might be one of the reasons for the differences in results. For instance, McBride-Chang and colleagues included measures on visual-spatial relationship and tone detection but the present study did not, while the present study included measures on oral language, phonological memory, rapid naming of pictures, paired-associate learning, and orthographic skills that McBride-Chang's study did not. Based on the results of these two studies, apart from confirming the significant role of rapid naming in learning to read as found in many previous studies on alphabetic languages, the specific role of morphological awareness for learning to read the meaning-based language, Chinese, is also reconfirmed (McBride-Chang et al., 2003, 2005, 2010).

It is noteworthy that preschool paired-associate learning remained a significant predictor of Chinese word reading at Grade 1 even when the autoregressor was controlled. Paired-associate learning appears to be especially important for learning to read Chinese, a system with rather arbitrary associations between script and sound. This early learning ability continues to be important in Grade 1 when children encounter new characters and words. New word learning requires learning of considerable new visual-verbal associations especially before some orthography-phonology regularities or rules are mastered. Orthographic rules may not be well established in Grade 1 or before. Therefore, preschool orthographic skills were not found to be a significant predictor of Chinese word reading in Grade 1. The role of orthographic skills may become more important in later elementary school years. This suggestion may be further tested in future research.

Onset and persistence of reading difficulties

Past research findings have shown the high persistence of reading difficulties for children with dyslexia (e.g., Butler et al., 1985; Francis et al., 1996; Jacobson, 1999), and early failure in reading is a strong predictor of later reading problems (Fletcher et al., 1984; Jacobson, 1999). However, little is known whether reading difficulties in preschool years persist up to elementary grades. The present findings show that all of the Chinese dyslexic readers and 94 % of the poor word readers had word reading difficulties in at least one preschool year, while 65–67 % of them had difficulties in two or three preschool years. This suggests that the onset of reading difficulties may appear very early and may persist at least until Grade 1. This may partly explain why preschool predictors failed to be significant when the autoregressive effect of reading was controlled. Early reading performance or difficulties seem to be the best predictor of later reading outcome than other factors. In other words, early acquisition of basic reading skills is a critical foundation for the development of reading competence at a later age. This important finding calls for early identification of children at risk with reading difficulties in preschool years and this would allow early intervention to take place. Some studies have shown that many impaired readers can acquire at least grade-level reading skills if they are identified early and are provided tailor-made comprehensive and intensive reading instruction (e.g., Scanlon, Vellutino, Small, & Fanuele, 2000; Torgesen, Rose, Lindamood, Conway, & Garvan, 1999). To achieve early identification, a Chinese preschool screener, The Hong Kong Reading Ability Screening Test for Preschool Children (Ho et al., 2011a), has recently been published to help identify Chinese preschool children at risk with reading difficulties.

Limitations and suggestions for future research

The low number of children with familial risk being diagnosed with dyslexia in Grade 1 was rather unexpected. This might be related to the recruitment method in the present study which was based on community sampling of families mainly with dyslexic parents. Families with dyslexic parents may be confounded with lower SES as dyslexic individuals tend to have less well academic and career achievement than non-dyslexic individuals. Although differences in family income were statistically controlled, there might be other confounding environmental factors not being taken into consideration. Therefore, with the relatively low incidence of dyslexic cases in the present study, interpretation about the logistic regression results predicting the dyslexia outcome may be taken with some caution. Future studies may compare directly whether families with dyslexic parents versus dyslexic siblings pose different risk factors to children's literacy development.

Conclusions

To conclude, the present findings show that Chinese children with familial risk tend to have more literacy-related difficulties, especially in phonological awareness, (though not more children meeting the dyslexia classification) than children from low risk families in Grade 1. It was also found that preschool oral language skills, phonological awareness, and print-related skills together correctly predicted 97 % of children's dyslexia status in Grade 1. Similar core deficits for reading difficulties seem to apply to learning different writing systems, both alphabetic and non-alphabetic ones. With all the dyslexic readers and 94 % of the poor word readers having word reading difficulties in at least one preschool year, the early onset and high persistence of reading difficulties call for early identification and early intervention.

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