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Executive Functioning Skills Uniquely Predict Chinese Word Reading

Kevin K. H. Chung
The Hong Kong Institute of Education

Catherine McBride-Chang
The Chinese University of Hong Kong

Eighty-five Hong Kong Chinese children were tested across both the 2nd and 3rd years of kindergarten (ages 4-5 years) on tasks of inhibitory control, working memory, vocabulary knowledge, phonological awareness, morphological awareness, and word reading. With age, vocabulary knowledge, and metalinguistic skills statistically controlled, the combination of working memory and inhibitory control together independently explained approximately 14%–16% of the variance in word reading at both ages. Furthermore, the executive functioning skills as a block contributed unique variance to word reading at Time 2, even when word recognition at Time 1 was statistically controlled. These findings highlight the unique importance of executive functioning skills, even beyond vocabulary knowledge and metalinguistic awareness, for the development of Chinese word recognition in beginning readers of Chinese.

Keywords: executive functioning skills, metalinguistic skills, reading achievement, Chinese word recognition

The ability to predict reading performance in very young children is crucial in order to ensure continued learning success. Although solid metalinguistic skills are integral to children's reading acquisition (e.g., Adams, 1990; Ziegler & Goswami, 2005), some researchers have begun to recognize the importance of executive functioning skills for reading development as well, particularly in English-speaking societies (e.g., Alexander, Entwisle, & Dauber, 1993; Diamond, 2006; Ladd, 2003; McClelland, Cameron, Wanless, & Murray, 2007; Miller & Cohen, 2001). Conversely, difficulties in executive functioning skills are sometimes linked to learning difficulties (Alexander et al., 1993; Ladd, 2003). Relatively little research has been conducted on links between executive functioning skills and early reading achievement in Asian societies such as Hong Kong's, however. Because Hong Kong children enter first grade with about 3 years of formal literacy teaching behind them, those with low reading skills at first grade presumably already are at risk for failure. Thus, in the present study, we tested two aspects of executive functioning skills, working memory and inhibitory control, as potential predictors of early reading variance in a group of typically developing Hong Kong Chinese children, with the aim of eventually understanding the extent to which these two skills might serve as unique indicators of reading difficulties in very young Chinese children. Given the nature of the Chinese orthography, there are good reasons to expect that both working memory and inhibitory control might be important in the early stages of Chinese literacy acquisition.

Chinese is a formidable orthography, requiring many more years of parental and school-based input than does alphabetic reading, just to master basic word-reading skills (e.g., Li & Rao, 2000). In addition, reading acquisition in Chinese is a more multifaceted learning situation than is alphabetic reading mastery (Ho, Chan, Lee, Tsang, & Luan, 2004; Ho, Ng, & Ng, 2003). To begin with, Chinese is not a phonologically reliable orthography (e.g., Shu, Chen, Anderson, Wu, & Xuan, 2003), so phonological awareness is not necessarily the key to promoting word reading in this script, as it often can be in alphabetic orthographies (e.g., Adams, 1990). Thus, among young Hong Kong Chinese children, phonological awareness sometimes is uniquely associated with word reading across time (e.g., Chow, McBride-Chang, & Burgess, 2005), though sometimes it is not (e.g., McBride-Chang et al., 2011).

One metalinguistic skill that has been linked to early Chinese reading acquisition is morphological awareness, which refers to sensitivity to morphemes within words. Many Chinese characters are homophones. One way in which the Chinese language disambiguates these homophones is via lexical compounding. An example in English would be to understand that the *maid* in *bridesmaid* is the same as that in *milkmaid* but not the same as that in *handmade*. Because Chinese consists of so many characters that are either homophones or homographs of one another, Chinese children who are skilled in distinguishing homophones and in the ability to form compound words or other sensible lexical compounds tend to be better readers than those who are not (e.g., McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003).

On the other hand, there are additional skills required for Chinese acquisition that are only minimally important for alphabetic reading. For example, the order in which strokes comprising Chinese characters are written is fixed and not necessarily self-evident. Writing is, therefore, a huge component of literacy acquisition in Chinese because of the planning involved (e.g., Tan,

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Kevin K. H. Chung, Social and Cognitive Neuroscience Unit, Department of Special Education and Counselling, The Hong Kong Institute of Education, Hong Kong, China; Catherine McBride-Chang, Department of Psychology, The Chinese University of Hong Kong.

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Correspondence concerning this article should be addressed to Kevin K. H. Chung, Social and Cognitive Neuroscience Unit, Department of Special Education and Counselling, The Hong Kong Institute of Education, 10 Lo Ping Road, Tai Po, N.T., Hong Kong, China. E-mail: kevin@ied.edu.hk

Spinks, Eden, Perfetti, & Siok, 2005). In addition, there are literally thousands of Chinese characters in existence, and distinguishing them in print is often confusing. For example, for a beginning reader, distinguishing 火 [fo2][1] (fire), 大 [daai6] (big), 犬 [hyun2] (dog), 太 [taai3] (too), 天 [tin1] (sky), 夫 [fu1] (husband), or 失 [sat1] (lose) may be difficult because visually (at least holistically) the features do not necessarily appear to differ strongly from one another. Given the plethora of requirements for successful mastery of the Chinese orthography, many of which are not yet well understood, in the present study, we specifically examined the extent to which executive functioning skills alone, apart from other known linguistic correlates of Chinese word reading, uniquely would explain reading acquisition in Chinese, both concurrently and longitudinally in 4- to 5-year-old children.

Executive functioning, defined broadly as the ability to regulate mental functions, allowing individuals to regulate themselves and engage in directed behavior (Lyon & Krasnegor, 1996), has been shown to be associated with learning in both Korea and China (Oh & Lewis, 2008; Sabbagh, Xu, Carlson, Moses, & Lee, 2006). Executive functioning skills encompass a range of cognitive processes that often include attention shifting, updating, working memory, and inhibitory control. However, working memory and inhibitory control have been identified as the major aspects of executive functioning that contribute to young children's early academic achievement (Berlin & Bohlin, 2002; Blair & Razza, 2007). These skills have been identified mostly in kindergarten children in Western cultures, particularly in the United States and Britain (Diamond, 2006; Miller & Cohen, 2001).

In cross-cultural comparisons, it has been suggested that Asian children tend to show different developmental patterns of executive functioning skills than do Western children of the same age (Oh & Lewis, 2008; Sabbagh et al., 2006). Korean and Chinese children seem to show higher levels of performance on tests involving executive functioning skills than their British and U.S. counterparts (Oh & Lewis, 2008; Sabbagh et al., 2006). Still, cultural group differences do not preclude the possibility of individual differences within a culture being associated with particular learning outcomes. For example, there are some studies on the relation between executive functioning and reading acquisition in English (Altemeier, Abbott, & Berninger, 2008; Blair & Razza, 2007; Welsh, Nix, Blair, Bierman, & Nelson, 2010). These studies tend to show a positive association between executive functioning skills and literacy acquisition. At the same time, however, these studies have not typically examined such skills in relation to other previously established reading-related skills in explaining reading development. Few studies, if any, have investigated these together as executive functioning skills in Chinese. Therefore, it is unclear what role executive functioning skills play in Chinese writing systems, which feature a lack of grapheme–phoneme conversion rules in addition to a rich lexical compounding morphology. In the present study, therefore, we tested the unique importance of both working memory and inhibitory control, two central components of executive functioning skills, for reading in Chinese, with other known linguistic skills relevant to Chinese reading acquisition (i.e., vocabulary knowledge, phonological awareness, and morphological awareness) statistically controlled.

Working memory is a multicomponent construct of executive function that has been associated with reading development in both typically developing children and children with reading problems (e.g., Blair, 2003; Welsh et al., 2010). It refers to the system underlying the maintenance and processing of information necessary for complex cognitive activities such as spoken and written language comprehension, mental arithmetic, reasoning, and problem solving (Baddeley, 1986). Working memory is assumed to consist of multicomponent memory systems including a visuospatial sketch pad for dealing with visuospatial input, a phonological loop for dealing with verbal speech input, and a central executive as a controlling, regulating component coordinating the overall system. Also, the episodic buffer, the purpose of which is to integrate information from different subsystems, and long-term memory, which is essential for holding in mind a multimodal code, are both controlled by the central executive (Baddeley, 2000). Working memory is generally considered to have a limited capacity. However, extensive knowledge acquired from experience in a particular area can be used to overcome the limitation of working memory capacity (Ericsson & Kintsch, 1995). It is assumed that through practice and study, skilled readers may store information rapidly and activate relevant knowledge structures in their long-term memory. Individual differences may therefore reflect variations in working memory capacity that may play a different role in the case of skilled and less skilled readers or beginning learners.

Previous studies have investigated the relationship between working memory capacity, particularly verbal working memory, and reading acquisition in both alphabetic and Chinese languages (e.g., Kormos & Sáfár, 2008; Savage & Frederickson, 2006; Seigneuric & Ehrlich, 2005). Such associations are particularly marked when children with and without specific reading difficulties are compared. For example, Zhang, Zhang, Chang, and Zhou (1998) and Chung, Ho, Chan, Tsang, and Lee (2010) found that Chinese children with reading problems performed worse than did typically achieving children in verbal memory tasks. In another now classic cross-cultural study, Stevenson, Stigler, Lucker, Hsu, and Kitamura (1982) demonstrated that poor Chinese readers made more errors in verbal memory and memory for words than did typically achieving children. At the same time, however, verbal memory skill is not always uniquely associated with word reading skill once other reading-related abilities, such as phonological awareness, are included. This is likely to some extent attributable to the fact that verbal memory is, at least implicitly, a focal component of phonological awareness tasks themselves (e.g., McBride-Chang, 1995). In alphabetic orthographies, phonological awareness tasks are strongly associated with reading development, but verbal memory tasks are less directly associated with word reading once phonological awareness is statistically controlled (e.g., McBride-Chang, 1996). Thus, research on the association of working memory to word reading has yielded mixed results. The present study tested the extent to which working memory would predict early Chinese character reading.

In the present study, our measure of working memory was the forward and backward digit span test from the Wechsler Intelligence Scale for Children (3rd ed.; WISC–III; Wechsler, 1991). This task not only taps memory span but also children's abilities to monitor and manipulate verbal information in memory. The digit

[1] Cantonese characters appearing here have been transcribed into Cantonese Romanization standardized by the Linguistic Society of Hong Kong (1993). Numbers indicate lexical tones.

span measure has often been included as a measure of executive functioning (Cutting, Materek, Cole, Levine, & Mahone, 2009; Glisky, Polster, & Routhieaux, 1995). A few studies have included this measure in previous studies of Chinese literacy acquisition (e.g., Chung et al., 2010; Zhang et al., 1998). For instance, Chung et al. (2010) found that backward digit span was related to Chinese word reading and could successfully distinguish disabled from nondisabled readers. We hypothesized that this measure would be uniquely associated with reading skill even in a typically developing sample of young Chinese children because of the relatively great demands on memory that are required in learning to recognize Chinese characters.

The “set” of Chinese characters appears, at least to a young child, to be almost infinite. In fact, the number of characters required to be learned number in the thousands. This learning demand, compared with the set of 26 letters in the English alphabet, is extraordinary. Although there are indeed many orthographic patterns that facilitate character acquisition over time (e.g., Ho et al., 2003; Shu & Anderson, 1997) for young children, early Chinese character recognition is likely to rely relatively heavily on individual learning. For those who are not yet fully immersed in the process of learning to read, each character may be learned individually as a kind of logograph or unique symbol, as Ehri and Wilce (1985) found for “prereaders,” very young children learning to read English. Given this initial approach, which is reinforced by the look-and-say approach to teaching in Hong Kong, where children are encouraged to memorize characters completely, working memory is essential. Children must not only memorize a large variety of visual patterns but also map these onto a large number of homophones and homographs (e.g., Shu, McBride-Chang, Wu, & Liu, 2006). Such manipulations imply that children must constantly remember that 大 [daai6] (big) is written as 大 and 太 [taai3] (too) is written as 太, that these share most of the strokes but not all, and that they rhyme, for example. 句 [geoi3] (sentence) and 可 [ho2] (permit), 向 [hoeng3] (toward), 回 [wui4] (turn), and 同 [tung4] (same) may holistically have similar visual features, but their uses and pronunciations are completely different. Because of these memory demands, we hypothesized that this memory task would be uniquely associated with early word reading in Chinese.

We similarly hypothesized that inhibitory control would be a unique predictor of Chinese word recognition as well. Inhibitory control represents another component of executive function skills that has associations with literacy development (van der Sluis, de Jong, & van der Leij, 2007). It has been conceptualized as the ability to focus attention and suppress irrelevant information in order to act appropriately (Dempster, 1992; Diamond, 2006; Moutier, Plagne-Cayeux, Melot, & Houdé, 2006). Inhibitory control is probably involved in the processes of encoding and retrieval of linguistic information during reading. Efficient processing and retrieval of information, for example, may be affected by the ability to inhibit attention to distractors and make possible selective attention while engaged in the rapid search and recall of the relevant information. Indeed, inhibition control has been linked specifically to reading, with children with strong inhibitory control displaying higher achievement in reading (Blair & Razza, 2007).

In a number of studies (e.g., Berlin & Bohlin, 2002; Simpson & Riggs, 2005), inhibitory control was studied using inhibition tasks such as the day–night test based on the Stroop paradigm (Gerstadt, Hong, & Diamond, 1994). In this task, children are presented with either a daytime picture of the sun or a nighttime picture of the moon and are instructed to say “night” upon presentation of the daytime picture and “day” upon presentation of the nighttime picture. Berlin and Bohlin (2002) found predictive links between children’s inhibitory control reflected in their day–night performance and their subsequent reading achievement. These previous studies have focused primarily on reading achievement in alphabetic languages. However, given the demands of Chinese reading for beginners as described thus far, we assumed that this ability to suppress irrelevant information would be particularly important for learning to read Chinese. Again, both because Chinese characters often are visually confusable at least holistically (i.e., to a beginning learner) and because Chinese has so many homophones/homographs, demands on Chinese children to suppress one idea about the nature (i.e., sound, meaning, or written form) of a morpheme or character in favor of another one are great. Therefore, we were interested in comparing directly the associations of inhibitory control to word reading, with other linguistic skills statistically controlled.

One of these linguistic skills that we statistically controlled was vocabulary knowledge itself (e.g., Nation & Snowling, 2004; Ouellette, 2006; Roth, Speece, & Cooper, 2002; Wise, Sevcil, Morris, Lovett, & Wolf, 2007). Vocabulary knowledge has been measured in a variety of ways, including general measures of both expressive and receptive vocabulary knowledge in English (e.g., Botting, Faragher, Simkin, Knox, & Conti-Ramsden, 2001) and in Chinese (e.g., McBride-Chang & Ho, 2005). Oral vocabulary was found to be one of the best predictors for Chinese word recognition in Chinese–English bilingual children. In other studies (McBride-Chang & Ho, 2005; McBride-Chang & Kail, 2002), oral vocabulary was used as a proxy for general cognitive ability in relation to word reading. In the present study, we included measures of both expressive and receptive vocabulary knowledge both to test the extent to which they would be uniquely predictive of Chinese word reading and to control for these in examining the effects of the two executive functioning variables of primary interest.

A second linguistic variable that was included in the present study was phonological awareness, that is, the recognition of and ability to manipulate the sound structure of words. Research, including a variety of measures of phonological awareness from syllable awareness, to onset–rime awareness, to phonemic awareness, has demonstrated that phonological awareness is often associated with Chinese character recognition in Chinese children (Ho & Bryant, 1997; Hu & Catts, 1998; Huang & Hanley, 1994, 1995; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001; So & Siegel, 1997). In the present study, we tested phonological awareness relatively comprehensively in a single measure using items tapping both syllable and phoneme onset deletion.

The final linguistic skill we included in the present study was morphological awareness. Morphological awareness is the recognition of and ability to manipulate the meaning structure of language (Carlisle, 1995). In Chinese, morphological awareness at the level of oral language alone includes both the ability to distinguish meanings across homophones or homographs and also the ability to manipulate and access morphemes in words with two or more morphemes (e.g., McBride-Chang et al., 2003). In part because of a relatively large number of Chinese syllables sharing the same sounds or homophones, many syllables may have more than one homophone, each with a different meaning (e.g., Packard, 2000;

Zhou, Zhuang, & Yu, 2002). One Cantonese syllable with a specific tone can have multiple meaning, for example, 二 [ji6] (two), 義 [ji6] (meaning), 易 [ji6] (easy) and 異 [ji6] (different). In addition, most Chinese words are made up of two or more morphemes. Many words can, therefore, share the same morpheme, as in 百合花 [baak3 hap6 faa1] (lily), 玫瑰花 [mui4 gwai3 faa1] (rose), and 菊花 [guk1 faa1] (chrysanthemum). All of these words, sharing the morpheme [faa1] (flower), are semantically related as indicated by this morpheme. Given these combined characteristics of the large number of homophones and word compounding in Chinese, awareness of morphemes is particularly important in learning to read Chinese (McBride-Chang et al., 2005). Thus, in the present study, we included a measure of morphological awareness tapping both homophone/homograph and compounding sensitivity in Chinese.

To summarize, several previous studies of Western children have demonstrated that executive function skills are associated with reading performance over the kindergarten years (e.g., Blair, 2002; Blair & Razza, 2007; Bronson, 2000; McClelland et al., 2007). These studies have focused primarily on the importance of general self-regulation skills for academic achievement. Although no studies have specifically tested the association between executive functioning skills and reading achievement in Asian societies, it is clear that some Asian children, particularly those from Korean and Chinese societies (Oh & Lewis, 2008; Sabbagh et al., 2006) tend to outperform their Western counterparts on early executive functioning tasks in the preschool years. It is, therefore, possible that such advanced executive functioning skills diminish the importance of these skills in predicting early reading achievement in Chinese children. However, cross-cultural group differences cannot address the issue of how particular variables behave within a given society. In the present study, our primary interest was in two specific executive functioning skills as correlates of reading performance in Chinese. Given the advanced memory, planning, and even inhibitory skills required to learn to read Chinese, we hypothesized that executive functioning skills, both individually and together, would be unique correlates of beginning Chinese word reading, even if we controlled for other previously recognized reliable predictors of Chinese literacy acquisition (i.e., vocabulary knowledge, phonological awareness, and morphological awareness). We tested these associations both concurrently and longitudinally over 1 year in kindergarten children who were between 4 and 5 years old.

Method

Participants

Participants were 85 children (42 girls, 43 boys) from three kindergartens in Hong Kong who completed all testing at both testing times. These kindergartens were located in a middle class neighborhood in Shatin area, New Territories, and primarily served middle-class families. Based on the demographic information collected, approximately 60% of the parents had average household income ranging from HK$20,000 (US$2,570) to HK$90,000 (US$11,540) or above per month. The majority of parents were clerical workers (31.5% mothers and 12% fathers) and professionals (22.8% mothers and 32.7% fathers). The median household income of Hong Kong in 2006 was HK$17,250 (US$ 2,211and that of Shatin district was HK$19,320 (US$2,477) (Hong Kong Census and Statistics Department, 2007). Teachers were also asked to report whether any of the children had known developmental, speech, language, or behavior problems; such children were excluded for this study. All participants were from Cantonese-speaking families and were attending Cantonese-medium schools. The first testing time was in the second semester of the children's second year of kindergarten (K2). The second testing time was in the second semester of their third year of kindergarten (K3). The average age of the children at Time 1 was 59.87 months (range = 53–74 months); at Time 2, their mean age was 70.98 months (range = 64–93 months).

In Hong Kong, the majority of children attend kindergarten for 3 years from the age of 3. Typically, they are taught to read Chinese multiple-character words and short phrases in K2. Thus, on average, by the end of K3, children are expected to know approximately 150–200 characters and can read some short phrases and sentences.

Procedure

All testing took place at school. Testing at Times 1 and 2 consisted of three individually administered sessions. The children participated in three individual sessions, each of which lasted approximately 25–30 min. After each session, children were given stickers in appreciation for their participation. All tests were administered by trained experimenters. The order of tasks was counterbalanced. The following measures were administered.

Reading measure. To assess word-reading ability, we combined one- and two-character words used previously (e.g., McBride-Chang & Ho, 2000) with a character-recognition task from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (Ho, Chan, Tsang, & Lee, 2002) consisting of 60 two-character words. All children were asked to read from the beginning of the test, with the words increasing in difficulty level. Children were required to read aloud the words from left to right and top to bottom. The Cronbach's alpha reliability coefficient was .97.

Metalinguistic measures.

Phonological awareness. The format of this test was based on that of the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999) and has been used successfully in previous studies of Hong Kong Chinese children (Chung et al., 2008; Tong, McBride-Chang, Shu, & Wong, 2009). We tested phonological awareness using syllable-deletion and onset-deletion items in a graded difficulty format. All stimuli were presented orally by the experimenter. In the first part of this task covering syllable deletion, there were 15 real words and 14 pseudowords, each composed of three syllables. On each trial, the children were required to take away either the first, second, or third syllable and say aloud what was left. For example, the children were asked to say /din6/ /daan1/ /ce1/ without /din6/. The correct answer is /daan1/ /ce1/. In the second part of the test, 10 real and 12 pseudowords with one syllable were used. The children were asked to drop the first consonant (i.e., phoneme onset) of each item and say aloud what was left. For example, to produce the syllable /so1/ without the initial sound would be /o1/. Each item of the test was awarded a point to comprise a total composite phonological awareness score. The maximum score of this task was 51. The Cronbach's alpha of the measure was .94.

Morphological awareness. Similar to the idea and process used for the measure of phonological awareness, morphological awareness was measured by combining performances on tasks of morphological construction with homophone production by graded difficulty level. This test was also used in previous research (Chung et al., 2008; Tong et al., 2009). In the first part of the test, children were tested on lexical compounding, with 27 scenarios presented in the context of two- to four-sentence stories. The children were then asked to come up with words for the objects or concepts presented by each scenario. One example follows:

> 朝頭早既時候日頭出嚟, 我哋叫佢做日出咁*夜*晚既時候月*亮*出嚟, 我哋會*點*叫佢呀? (Early in the morning, we can see the sun coming up. This is called a sunrise. At night, we might also see the moon coming up. What could we call this?)

The correct response here was *moonrise*. Following this lexical compounding section, there were 14 items tapping homophone production. For these items, the children were given 20 s for each item to produce Chinese words that contained the target morpheme and the homophone of the target morpheme. For example, one possible set of correct responses for the target morpheme 書 [/syu1/] (book) would be 書包 [/syu1/ /baau1/] (schoolbag) for the target morpheme and 輸送 (輸 [/syu1/] is a homophone of this morpheme of 書 [/syu1/]; 輸送 [/syu1/ /sung3/], meaning *transmit*). We computed a composite score by summing the scores across the lexical compounding and homophone production items. The maximum of morphological awareness score was 27. The Cronbach's alpha of the measure was .87.

Vocabulary measure.

Vocabulary definitions. This task required that children produce explanations for vocabulary items and was similar to those used in previous studies (McBride-Chang, Tardif, et al., 2008; Tong et al., 2009) of young children's vocabulary knowledge. It consisted of 53 words selected from a book listing Chinese words in Hong Kong primary school textbooks (Zhuang, 2000) as well as some pilot testing in kindergartens; items were arranged in order of ascending difficulty. Children were orally presented with a word representing an object or concept and asked to explain or define this word. One example of an item in this task is "What is a towel?" The testing procedures and scoring scheme of the Hong Kong Wechsler Intelligence Scale for Children (Hong Kong Education Department & Hong Kong Psychological Society, 1981) were used to score the children's definitions. A scoring scheme for each item was created from the descriptions provided by a Chinese dictionary (Lau, 1999). Sample answers for scores of 0, 1, and 2 per question were also included in the scoring scheme. Children's answers were given for each item according to the scoring scheme. Testing stopped when the children provided 0-point responses for five consecutive items. Because this test was created for children from kindergarten through sixth grade, scores for younger children on the measure were expected to be relatively low. However, the maximum score was 106. The internal consistency reliability of this task was .69 (Cronbach's α).

Receptive vocabulary knowledge. The vocabulary items were translated and modified from Version B of the Peabody Picture Vocabulary Test (3rd ed.; PPVT–III; Dunn & Dunn, 1997). The PPVT–III is a measure of receptive language skills. The 60 vocabulary items that were selected to be tested in this study were chosen on the basis of local context and the results of a pilot study of children in both K2 and K3. The items were organized into six subsets of varying difficulties. Each item consisted of four black-and-white illustrations that were arranged on a picture plate. The items were administered orally. Children were then required to select the picture that best depicted the meaning of a word presented orally by the experimenter. All the items were administered to each child on this test. The maximum score was 60. The Cronbach's alpha reliability coefficient was .86.

Executive function measure.

Inhibitory control. This task was based on the classic Stroop paradigm with a set of four picture pairs (day–night, boy–girl, large–small, and up–down) used in previous studies (Berlin & Bohlin, 2002; Gerstadt et al., 1994). In this task, the children were presented with three pairs of pictures; each pair was composed of pictures depicting opposites (day–night, black–white, and up–down). The total number of trials was 48, and each pair consisted of 16 trials. For example, in the day–night task, the experimenter presented cards depicting a picture of the sun and cards depicting a picture of the moon. Children were asked to say "night" in response to sun cards and to say "day" in response to moon cards. This test measures inhibition because it requires children to inhibit a prepotent response (i.e., to say what the picture normally represents) and instead say the opposite (Simpson & Riggs, 2005).

Two practice trials were given. After ensuring that the children understood what each picture represented, the experimenter instructed the children to say the opposite as fast as possible every time they saw a picture on the flash card. If children performed successfully, the test phase continued from that point. If children did not succeed on the first two practice trials, the experimenter reminded them of the rule and started again. Each correct trial was worth one mark, and the maximum of inhibitory control score was 48. The Cronbach's alpha reliability coefficient was .97.

Working memory. Working memory was assessed with the forward and backward digit span test based on the Wechsler Intelligence Scale for Children (3rd ed., WISC–3; Wechsler, 1991). These tasks tapped into the children's mental manipulation of verbally presented information. With the forward digit span task, children listened to a series of digits and then repeated the numbers in the same order. For the backward digit span test, children were required to repeat a list of numbers in the reverse order from which they were originally presented. Digit spans ranged in length from two to eight digits and consisted of 28 trials in total. These memory tasks were tape-recorded at a rate of 1 item per second. Children, wearing headphones, listened to each tape and immediately recited the given number string back to the experimenter. The maximum score for accomplishing both digit span tests was 28. The internal consistency reliability of this task was .87 (Cronbach's α).

Results

The means, standard deviations, ranges of standardized scores, paired t values (comparing performances across testing times), and effect sizes for each task administered at Times 1 and 2 are displayed in Table 1. These comparisons showed differences in word reading, vocabulary knowledge, metalinguistic awareness, and executive functioning, with all scores being significantly

Table 1
Descriptive Statistics for All Variables at Time 1 and Time 2

Variable	Time 1				Time 2					
	M	*SD*	Min	Max	*M*	*SD*	Min	Max	*T* value	Effect size
Word reading	28.87	16.12	0	58	32.56	12.73	12	60	3.52	0.36
Receptive vocabulary knowledge	30.65	7.42	15	48	39.73	5.86	24	52	12.67	0.81
Vocabulary definitions	14.51	4.74	4	25	19.22	6.36	9	36	6.49	0.58
Phonological awareness	15.89	7.52	0	29	22.51	5.11	7	29	9.58	0.72
Morphological awareness	8.44	5.10	1	26	13.15	4.60	1	24	8.08	0.66
Working memory	6.92	3.64	1	14	8.67	3.70	2	17	3.79	0.38
Inhibitory control	34.73	10.08	14	48	37.32	9.05	10	47	2.85	0.30

Note. Min = minimum; Max = maximum.

higher for Time 2 than for Time 1. We calculated pre–post effect sizes (Cohen's *d*, 1992) based on the suggestion from Rosnow and Rosenthal (2005). Cohen's *d* (1992) was used to interpret effect values as 0.20 = *small*, 0.50 = *medium*, and 0.80 = *large effect*. As shown in Table 1, relatively large effects were demonstrated for receptive vocabulary knowledge, vocabulary definitions, phonological awareness, and morphological awareness, whereas a medium effect size was obtained for word reading, as well as for working memory and inhibitory control measures as components of executive function.

Correlational Analyses

Table 2 indicates Pearson's correlations among all relevant measures. That is, correlations among receptive vocabulary knowledge, vocabulary definitions, phonological awareness, morphological awareness, inhibitory control, working memory, and word reading outcome measures across time are all shown in Table 2. Correlations of phonological awareness, morphological awareness, receptive vocabulary knowledge, vocabulary definitions, inhibitory control, and working memory with the word reading task were moderate, ranging in magnitude from 0.35 to 0.47 at Time 1. A similar pattern was found at Time 2, with correlations ranging from 0.29 to 0.46. Cross-lag (Times 1 and 2) correlations for metalinguistic awareness, vocabulary knowledge, executive function, and word reading tasks ranged from 0.31 to 0.80. Magnitudes of all correlations of phonological awareness, morphological awareness, receptive vocabulary knowledge, vocabulary definitions, inhibitory control, and working memory with the word reading task were moderate, ranging from 0.35 to 0.54.

Regression Analyses: Predicting Word Reading From Concurrent Predictors

We then carried out a series of hierarchical multiple regression to examine the relative contributions of measures of phonological awareness, morphological awareness, receptive vocabulary knowledge, vocabulary definitions, working memory, and inhibitory control for explaining variance in word reading both concurrently and longitudinally. To investigate the contribution of vocabulary knowledge, metalinguistic awareness, and executive functioning measures to concurrent and subsequent word reading, we con-

Table 2
Correlations Among Vocabulary Knowledge, Metalinguistic Awareness, Executive Function, and Chinese Word Reading Measures Across Time 1 and 2

Variable	Time 1								Time 2						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	—														
2. Word Reading	.10	—													
3. Phonological awareness	.30**	.47***	—												
4. Morphological awareness	−.20	.40***	.16	—											
5. Receptive vocabulary knowledge	.11	.35***	.33**	.28**	—										
6. Vocabulary definitions	.18	.44***	.42***	.30**	.15	—									
7. Working memory	.04	.48***	.26*	.20	.13	.16	—								
8. Inhibitory control	.18	.43***	.29**	.18	.16	.47***	.18	—							
9. Word reading	.16	.80***	.54***	.35***	.38***	.42***	.48***	.47***	—						
10. Phonological awareness	.03	.40***	.55***	.22*	.09	.33**	.19	.26*	.39***	—					
11. Morphological awareness	.11	.39***	.37***	.38***	.05	.27*	.13	.21	.34***	.29**	—				
12. Receptive vocabulary knowledge	.13	.31**	.41***	.15	.53***	.24*	.16	.13	.29**	.27*	.12	—			
13. Vocabulary definitions	.08	.48***	.34***	.18	.12	.31**	.31**	.11	.39***	.45***	.28**	.21	—		
14. Working memory	−.03	.46***	.12	.16	.01	.16	.32**	.15	.46***	.25*	.23*	.10	.28**	—	
15. Inhibitory control	.00	.38***	.30**	.16	.13	.32**	.22*	.62***	.37***	.23*	.20	.20	.23*	.28**	—

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

ducted hierarchical regression analyses for Time 1 and 2 separately. In the set of regression equations, the variable of children's age as a control measure was included in Step 1. Both receptive vocabulary knowledge and vocabulary definitions were entered at Step 2 because these have been established as correlates of reading across orthographies (e.g., McBride-Chang et al., 2003; Roth et al., 2002). Phonological and morphological awareness as metalinguistic awareness were entered in Step 3 given that they have both been shown to be important for word reading in young Chinese children (e.g., McBride-Chang & Ho, 2000; McBride-Chang & Kail, 2002; Shu et al., 2006). At Step 4, we included inhibitory control and working memory to investigate the unique and shared contributions of each for the word recognition outcome measure (Berlin & Bohlin, 2002; Diamond, 2006; Welsh et al., 2010). Concurrent correlates of word reading are displayed in Tables 3 and 4.

Table 3 specifically shows the results of a series of hierarchical regressions assessing the second grade kindergarten (Time 1) correlates word reading at Time 1. In Step 1, age accounted for 1% of variance in word reading as a control variable. Vocabulary definitions and receptive vocabulary knowledge were entered in Step 2 and accounted for an additional 27% of the variance explained in word reading. At Step 3, phonological awareness and morphological awareness accounted for a further 11 % of the variance in early word reading. On the final step, inhibitory control and working memory accounted for a further 13% of the variance in word recognition. As shown in Table 3, the final standardized beta weights for inhibitory control, working memory, phonological awareness, and morphological awareness at Time 1 were all significant. These analyses show that individual differences in vocabulary knowledge, metalinguistic, and executive functioning skills all accounted for unique variance in word reading. These findings suggest a broad range of skills required for early word reading in Chinese.

The next set of analyses examined the third grade kindergarten (Time 2) concurrent correlates of word reading (again at Time 2). Two sets of regression analyses are presented in Table 4. In the first regression equation displayed here, age by itself accounted for 1% of the variance in word reading at Time 2. In Step 2, vocabulary knowledge explained an additional 20% of the variance in word recognition. At Step 3, the concurrent metalinguistic awareness variables accounted for a further 8% of the variance in this skill. In the final step, the executive functioning measures collectively contributed 16% unique variance to word reading. As indicated in Table 4, in these analyses, only the final standardized beta weight for working memory was significant.

Table 3
Hierarchical Regressions Predicting Word Reading at Time 1 From Age, Vocabulary Knowledge, Metalinguistic Awareness, and Executive Function Measured at Time 1

Step/independent variable	Final β	Total R^2	ΔR^2	ΔF
1. Age	.12	.01	.01	0.79
2. Vocabulary definitions	.15	.28	.27	15.13***
Receptive vocabulary knowledge	.14			
3. Phonological awareness	.20*	.39	.11	6.98**
Morphological awareness	.19*			
4. Working memory	.31***	.51	.13	9.86***
Inhibitory control	.19*			

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

Table 4
Hierarchical Regressions Predicting Word Reading at Time 2 From Age, Vocabulary Knowledge, Metalinguistic Awareness, and Executive Function Measured at Time 2

Step/independent variable	Final β	Total R^2	ΔR^2	ΔF
Regression 1				
1. Age	.09	.01	.01	0.41
2. Vocabulary definitions	.11	.20	.20	9.65***
Receptive vocabulary knowledge	.18			
3. Phonological awareness	.16	.28	.08	4.28*
Morphological awareness	.12			
4. Working memory	.36***	.43	.16	10.58***
Inhibitory control	.16			
Regression 2				
1. Age	.06	.01	.01	0.41
2. Word reading	.68***	.64	.64	145.68***
3. Vocabulary definitions	.04	.64	.00	0.15
Receptive vocabulary knowledge	.05			
4. Phonological awareness	.08	.65	.01	0.62
Morphological awareness	.02			
5. Working memory	.14	.67	.02	2.08
Inhibitory control	.06			

*** $p < .001$.

As a more stringent test of the effects of vocabulary knowledge, metalinguistic awareness, and executive functioning on subsequent word reading at Time 2, the measure of word reading at Time 1 was additionally included in the regression equation. Regression 2 in Table 4 indicates that after age at Time 2 and word reading at Time 1 were included in the regression equation, none of the other variables accounted for unique variance in the equation. This was not particularly surprising given the strong overlap ($r = .80$) between word reading skills at Times 1 and 2. At the same time, these findings may also suggest that word reading itself might facilitate the development of vocabulary knowledge, metalinguistic skills, and executive functioning skills longitudinally, possibly diminishing the role of these "predictor" variables at Time 2.

To consider this possibility, we actually tested the extent to which Time 1 word reading predicted Time 2 executive functioning skills in simple regression analyses separately for working memory and inhibitory control. Time 1 working memory contributed 9% ($p < .01$) unique variance to Time 2 working memory; with Time 1 working memory statistically controlled, word reading at Time 1 contributed an additional 12.5% unique variance in working memory at Time 2. However, in the other regression analysis along this line, although Time 1 inhibitory control contributed a unique 38.5% ($p < .01$) of the variance to Time 2 inhibitory control, word reading at Time 1 in the second step contributed a nonsignificant 1.7% to Time 2 inhibitory control. Thus, evidence from the present data set that early word reading potentially influences subsequent executive functioning is mixed. In the analyses next described, we further tested the longitudinal association between inhibitory control at Time 1 and word reading at Time 2.

Regression Analyses: Predicting Word Reading From the Longitudinal Predictors

Table 5 displays these results of a set of hierarchical regression analyses assessing the longitudinal predictors of word reading at Time 2. There were two sets of regression analyses, termed Regressions 3 and 4 following the earlier regressions focused on Time 2 word reading as shown in Table 4. In both Regressions 3 and 4, all predictor variables included had been measured at Time 1. For Regression 3, age was entered in the first step as control variables and accounted for 3% of variance in word recognition. In Step 2, vocabulary knowledge accounted for a further 26% of this variance. In Step 3, variations in metalinguistic awareness accounted for 13% of additional variance in word reading. Finally, at the final step, executive functioning measures together accounted for a unique, significant 14% of the variance in word reading. Only the final standardized beta weights of inhibitory control, working memory, and phonological awareness were significant here as can be seen from Table 5.

In a more stringent test of the associations of the vocabulary knowledge, metalinguistic awareness, executive function, and word reading, both measures of word reading and age at Time 1 were included in the regression equation. In Regression 4, when age and word reading were entered at Steps 1 and 2, they accounted for 3% and 62% of variance in word reading, respectively. At Step 3, vocabulary knowledge accounted for an additional 2% of the variance in word reading; this was not significant. Metalinguistic awareness accounted for an additional 2% of the variance in word reading at Time 2 as well; again, this addition was not significant. Finally, at the final step, the two executive functioning variables collectively accounted for 3% of significant unique variance in word reading.

Discussion

The present study was among the first attempts to examine the extent to which executive functioning skills, beyond traditional linguistic and metalinguistic measures, uniquely explain early word reading in Chinese Consistently, for both Times 1 and 2, age, vocabulary knowledge, phonological awareness, morphological awareness, and executive functioning skills at Time 1 collectively explained over 50% of the variance in early word reading in these Chinese children. Even more strikingly, the combination of working memory and inhibitory control together explained a unique 13% of the variance in reading skill for Time 1 and 14% at Time 2; both were uniquely and independently associated with word reading. Even when word reading skill at Time 1 was statistically controlled, the executive functioning skills combination explained a unique 3% of the variance in Time 2 word reading. Time 2 executive functioning skills were similarly uniquely associated with Time 2 word reading, though once Time 1 word reading was statistically controlled, these were not uniquely predictive of Time 2 word reading. These findings are further discussed later.

Table 5
Hierarchical Regressions Predicting Word Reading at Time 2 From Age, Vocabulary Knowledge, Metalinguistic Awareness, and Executive Function Measured at Time 1

Independent variable	Final β	Total R^2	ΔR^2	ΔF
Regression 3				
1. Age	.02	.03	.03	2.25
2. Vocabulary definitions	.07	.29	.26	14.78***
Receptive vocabulary knowledge	.16			
3. Phonological awareness	.28**	.42	.13	8.74***
Morphological awareness	.14			
4. Working memory	.31***	.56	.14	12.52***
Inhibitory control	.24**			
Regression 4				
1. Age	.03	.03	.03	2.25
2. Word reading	.56***	.65	.62	144.34***
3. Vocabulary definitions	.01	.66	.02	1.74
Receptive vocabulary knowledge	.08			
4. Phonological awareness	.17*	.68	.02	2.59
Morphological awareness	.03			
5. Working memory	.13	.71	.03	3.59*
Inhibitory control	.14			

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

Such findings are potentially encouraging for parents and practitioners interested in predicting Chinese reading in very young children over time. Very young children are traditionally fairly difficult to test reliably. Admittedly, the associations of different tasks across 1 year were not all as consistent as one would like, with vocabulary definitions, morphological awareness, and working memory being correlated only moderately (r = .31–.38) over the year. However, receptive vocabulary knowledge (r = .53), phonological awareness (r = .55), and inhibitory control (r = .62) were quite stable across the year. This combination of stable results and the finding that executive functioning skills explained unique variance in word reading at both Times 1 and 2 highlights their importance as predictors of reading acquisition. Such results also provide an impetus for researchers to consider testing the efficacy of using such skills for identifying children who may be at risk for early reading difficulties. Early childhood researchers might be especially interested in applying these findings to early testing and play at school.

Consistent with prior work in English-speaking children (e.g., Blair & Razza, 2007; McClelland et al., 2007; Welsh et al., 2010), executive functioning skills predicted Chinese-speaking children's early reading performance. These skills likely promote the integration of visual and linguistic information from memory during reading. Specifically, working memory influences reading performance because of the need in word recognition to hold information in working memory while encoding and retrieving information from long-term memory. During this process, mental representation and focused manipulation of information are key. Inhibitory control, or the ability to suppress irrelevant information, plays a role in reading as well. Efficient encoding and retrieval of information, for example, may be affected by the ability to suppress irrelevant information while engaging in the rapid search and recall of relevant information. Our findings suggest that both aspects of executive functioning skills tested, namely, working memory and inhibitory control, are important for the development of early reading skills.

However, it should be noted that when the previous word reading of Time 1 was taken into account, executive functioning skills measured at Time 2 were no longer significant predictors of reading recognition at Time 2. Perhaps executive function skills may become less proximally and more distally associated with reading with increasing exposure to Chinese characters and reading proficiency. That is, with experience and development, efficient processing and recall of a large number of Chinese characters may occur without imposing a heavy working memory load or requiring extensive cognitive effort. If this were the case, it might additionally be that changes in executive functioning skills from Time 1 to Time 2 are no longer contributing to word reading because other processing skills that are more proximally associated with word reading skills, such as phonological awareness or lexical knowledge, might become stronger and thus might play a larger role in influencing reading performance. Further research is needed to clarify the ways in which different aspects of vocabulary knowledge, executive functioning, and metalinguistic skills are related to word reading with development.

One of the reading-related skills included in the present study was vocabulary knowledge, including both expressive and receptive vocabulary knowledge. These tasks were not significantly correlated with one another at either Time 1 or Time 2. Nevertheless, as a block, they did significantly explain early word recognition with only age statistically controlled across all analyses. These findings are consistent with previous work showing that vocabulary knowledge in kindergarten or first grade is significantly associated with and longitudinally predictive of word recognition (Nation & Snowling, 2004; Ouellette, 2006; Roth et al., 2002; Wise et al., 2007).

The metalinguistic skills of phonological awareness and morphological awareness together also significantly contributed to word recognition at Times 1 and 2, confirming previous findings that both are important to include in studies of early reading acquisition in very young Chinese children (e.g., Ho & Bryant, 1997; McBride-Chang & Kail, 2002; McBride-Chang et al., 2003; McBride-Chang, Lam, et al., 2008). Previous research evidence has demonstrated that both phonological awareness and morphological awareness not only play an important role in learning to read but also in distinguishing Chinese-speaking children with and without dyslexia (Chung & Ho, 2010; Chung et al., 2008, 2010; Ho et al., 2002, 2004). Admittedly, morphological awareness was not independently associated with word reading as often as phonological awareness was across regression analyses in the present study. Nevertheless, at least at Time 1, it was uniquely correlated with word reading. Both morphological awareness and phonological awareness should continue to be included in comprehensive batteries predicting early word reading in Chinese children in future research because both are fairly consistently associated with early language and word reading skills (e.g., McBride-Chang et al., 2008, 2011; Wong, Ciocca, & Yung, 2009; Wong, Kidd, Ho, & Au, 2010).

This study had at least five limitations that must be considered. First, we did not examine the issue of socioeconomic status (SES) diversity in the sample collected. The SES of families (Teale & Sulzby, 1986; Wells, 1985) has been identified as an important predictor of children's early language and cognitive functioning, behavioral adjustment, and academic achievement (Duncan, Brooks-Gunn, & Klebanov, 1994). Research indicates that low SES children tend to exhibit a lower level of literacy than their peers from high SES backgrounds (Aram & Levin, 2001; Duncan & Seymour, 2000). Future research should continue to explore the developmental patterns of language-related and cognitive functioning skills across different SES groups. Second, in future studies, the measures used in the battery could be extended to explain word reading performance. For example, we did not include tasks of rapid automatized naming in this battery, though tasks of speeded naming are uniquely associated with early reading skill (de Jong & van der Leij, 2003; Manis, Lindsey, & Bailey, 2004).

In addition, we only focused on the two components of working memory and inhibitory control that have most commonly been used with kindergarten children to tap executive functioning skills. These two measures also tend to be most closely associated with reading achievement (Fuchs et al., 2005; Swanson & Sachse-Lee, 2001). However, other research suggests that a wide range of components, including shifting, inhibition, working memory, and planning, should be considered as part of a comprehensive battery of executive functioning (e.g., Huizinga, Dolan, & van der Molen, 2006; Lehto, Juujaervi, Kooistra, & Pulkkinen, 2003; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). A fourth limitation to consider in evaluating the findings of the present study is that this work was limited to readers from Hong Kong. Because of the difference between simplified and traditional character scripts, as well as across languages, educational systems, and cultural norms among Chinese learners in Hong Kong, mainland China, and Taiwan, the extent to which our findings can be generalized across Chinese societies is not as yet fully understood. It is possible that different reading-related processing skills underlie children's early reading achievement may be found in these communities. Finally, it might be beneficial in future work to assess executive functioning skills with different types of indicators, including behavioral testing, parent and teacher reports, and classroom observation to construct more robust composition estimates of executive functioning skills. The present study was limited to single indicators of working memory and inhibitory control, and more measures of these might be useful in understanding more comprehensively their roles in early literacy development.

Despite these limitations, however, our results have both theoretical and practical implications in that they go quite some way toward explaining variance in early word-reading performance in Chinese children. The primary contribution of this study was its investigation of the relations and change in executive function, vocabulary knowledge, morphological awareness, and phonological awareness among preschoolers in relation to reading achievement at the end of kindergarten. Beyond various metalinguistic skills, executive functioning skills, particularly in the areas of working memory and inhibition skills, have also been shown to be an important component of word-reading ability. No study of any orthography has yet, to our knowledge, demonstrated the unique effects of working memory and inhibitory control on reading acquisition with other known reading-related skills statistically controlled. The nature of Chinese suggests that these skills may be particularly important for early word recognition in Chinese. This is both because of the very high memory demands in learning to recognize different characters and also the need to inhibit potentially conflicting information, including both homophones and homonyms as well as visually similar characters in print. Future studies can further test this idea, however. That is, although we have attempted to make a case particularly for why and how executive functioning skills may be particularly important in early reading acquisition in Chinese, it is also possible that these skills are directly associated with reading acquisition across orthographies.

Executive functioning skills also play an important role in the development of response to reading instruction and intervention programs. Unfortunately, there has been little research on the effects of training executive functioning skills. In Hong Kong, the look-and-say method has frequently been used for teaching Chinese characters (Ho et al., 2004; Holm & Dodd, 1996). In this method, children are taught to focus on the Chinese characters holistically, including their visual configurations, and to retrieve their pronunciation by rote. Thus, teachers often employ a drilling approach where numerous Chinese characters are presented, named, and read repetitively by students. In these circumstances, children may have problems dealing with different characters containing similar components but dissimilar sounds and words that have similar sounds but dissimilar characters (and meanings). It is possible that using the look-and-say method of teaching Chinese characters may not only impose heavy working memory load but also divert children's attention away from the target characters. A different approach to the promotion of learning characters could involve providing explicit instruction on the structure of characters and emphasizing the relations among their form, pronunciation, and meaning. For example, a teaching strategy that puts the emphasis on teaching the order of strokes, the shape of components, the accurate pronunciation of characters, and explanation of meaning in context should be considered (Tse, 2001).

Children should also be taught to learn characters in related clusters based on the components, meanings, or sounds so that similarities and variations among the related characters can be emphasized. Through this approach, executive functioning skills may be enhanced through the required suppression of attention to the irrelevant and reducing processing difficulty and storage loads as appropriate. One recent intervention study that focused on morphological skills by emphasizing some of these ideas via training in the classroom facilitated improved word reading in Hong Kong kindergartners (Zhou, McBride-Chang, Fong, Wong, & Cheung, in press). Such an approach may be particularly important for children with poor executive functioning skills. Further research is needed to examine the effects of this teaching approach.

An intervention program from North America called Tools of the Mind that emphasizes the training of executive functioning skills could also be integrated into the preschool curriculum in Hong Kong. This program includes exercises to help children remember and plan activities, activities to facilitate memory and attention, and dramatic play, fostering cooperative planning and role play in daily classroom activities (see Bodrova & Leong, 2007, for more details). A program evaluation study has shown that the Tools of the Mind program influences children's literacy development and improves their overall academic performance (Diamond, Barnett, Thomas, & Munro, 2007). Preschool children who participated in the program performed better on a wide range of metalinguistic tasks (such as vocabulary knowledge) associated with reading and expressed more interest in literacy activities than a control group. Although Hong Kong kindergarten teachers and parents tend to value academic activities such as formal literacy instruction over informal play within the kindergarten setting (e.g., Li & Rao, 2000), the diverse emphasis of this program on various aspects of executive functioning is appealing and potentially applicable, probably in modified form, within the Hong Kong educational system.

Although the importance of these findings for the development of effective early intervention programs with children at risk of reading difficulties may only gradually emerge with future work, the implications of these findings for early assessment are already clear. Assuming that future work continues to demonstrate the relatively high correlations between executive functioning skills and Chinese word reading found in the present study, practitioners should consider testing standard versions of these skills as they test young Chinese children for risk of reading failure. In only a very few studies have predictors of reading skill in children this young collectively explained more than 50% of the variance. Such findings may be of particular interest to clinicians, educational psychologists, and educators. The extent to which such findings apply across orthographies has yet to be determined but represents a promising direction to consider for those focused on school readiness skills across cultures.

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