Unique predictors of early reading and writing: A one-year longitudinal study of Chinese kindergarteners

Ying Wang, Li Yin, Catherine McBride

Department of Psychology, The Chinese University of Hong Kong, China
Department of Foreign Languages and Literatures, Center for the Study of Language and Psychology, Tsinghua University, China

Abstract

Children's early literacy development is a key contributor to later literacy skills and overall academic achievement. Because of the unique features of Chinese characters, it may be that predictors of literacy acquisition differ developmentally for reading and writing. In this study, we examined longitudinal predictors of reading and writing for 73 Chinese kindergarteners when they were 5; 2 (year; month) (range = 4; 9-6; 2). Word reading and writing were not significantly correlated at time 1 (T1), but were significantly associated with one another one year later (T2). At T1, the unique correlates of word reading were semantic radical awareness, rapid automatized naming, and vocabulary, whereas the only unique correlate of word writing was visual-orthographic copying skill. Semantic radical awareness at T1 uniquely predicted both word reading and word writing at T2, with age, nonverbal reasoning, and T1 performance statistically controlled. These results suggest that reading and writing differ in unique correlates in the beginning but change rapidly with development. Findings also shed light on the importance of semantic radical awareness in early literacy development in Chinese.

Keywords:
Early Chinese literacy development
Semantic radical awareness
RAN
Vocabulary knowledge
Visual-orthographic copying skill
Visual-motor skill

Early reading and writing skills among preschoolers and kindergarteners are important and strong precursors of children's later literacy skills and school achievement (National Institute of Child Health and Human Development, 2000; Whitehurst & Lonigan, 2001). Identifying the predictors of children's early literacy skills can help early childhood educators to understand what knowledge and skills should be emphasized in promoting reading and writing at different learning stages. For example, if a given cognitive linguistic skill that can be tested early in development is a strong predictor of subsequent word reading or word writing, it can be used for early identification of those at-risk for literacy difficulties. In addition, sometimes helping a child to practice such a skill helps to facilitate subsequent literacy abilities in young children. A familiar example is the fact that teaching the “ABC” song and corresponding letter names (and sounds) helps those learning to read the Roman alphabet to read relatively efficiently.

Children's early literacy development is influenced by a number of cognitive developmental skills, including phonological awareness, morphological awareness and speed of processing (Chow, McBride-Chang, & Burgess, 2005; Lei et al., 2011; McBride-Chang, Liu, Wong, Wong, & Shu, 2011; Shu, Peng, & McBride-Chang, 2008; Tong, McBride-Chang, Shu, & Wong, 2009). These skills are important across readers of various languages (Casalis & Louis-Alexander, 2000; Cho, McBride-Chang, & Park, 2008; Deacon & Kirby, 2004; Nikolopoulos, Goulandris, Hulme, & Snowling, 2006; Patel, Snowling, & de Jong, 2004).

Given that about one fifth of the population of the planet speaks Chinese as a native language as well as the increasing importance of Chinese as a global language for education and business, understanding Chinese literacy acquisition has become increasingly important. Reading and writing Chinese characters may require some unique skills different from those used in alphabetic languages (Chung & McBride-Chang, 2011; Spinks, Eden, Perfetti, & Siok, 2005). For example, identification of letter names is less crucial than is understanding of the components, particularly radicals, of Chinese characters. Also, to date, much more is known about word reading than word writing in Chinese. To fill in this gap, the present study sought to investigate which particular skills, both universal and unique, would best explain young Mainland Chinese children's performance in both reading and writing, concurrently and longitudinally.

The Chinese writing system is unique in its representation of sound and meaning. Each Chinese character represents both a syllable and a morpheme rather than a phoneme (DeFrancis, 1989; McBride-Chang & Kail, 2002). In addition, Chinese appears to be
particularly visually complex. A character consists of a configuration of strokes. The majority of the 2570 characters taught in primary school in Mainland China have 7–12 strokes; some have more than 20 strokes (Shu, Chen, Anderson, Wu, & Xuan, 2003). About 82% of modern Chinese characters are compound characters that consist of a semantic radical and a phonetic radical. Radicals are stroke patterns that recur across characters. The semantic radical gives some clue to the character’s meaning, and the phonetic radical gives some clue to the character’s pronunciation. Left-right and top–down structures are the two major types of structure of characters. In a left–right structure character the semantic radical usually appears on the left and the phonetic radical falls on the right, whereas in a top–bottom structure character, the semantic radical usually appears at the top and the phonetic radical usually appears at the bottom.

For Chinese word reading, previous studies have highlighted several correlates including morphological awareness (Li, Shu, McBride-Chang, Liu, & Peng, 2012; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003; Pan et al., 2011; Tong et al., 2009), rapid automatized naming (RAN), phonological awareness (Li, Peng, & Shu, 2006; McBride-Chang & Ho, 2005; McBride-Chang, Bialystok, Chong, & Li, 2004; Shu et al., 2008; Siok & Fletcher, 2001), and vocabulary knowledge (Pan et al., 2011; Shu, McBride-Chang, Wu, & Liu, 2006). More than 70% of Chinese words are compounds that consist of two or more morphemes (Institute of Language Teaching and Research of China, 1988). Even at the early stage of Chinese learning, children may recognize these patterns in compound words. Thus, as an aspect of Chinese morphological awareness, lexical compound awareness can be important for children’s beginning learning. RAN is usually assessed by very simple tasks where children name aloud symbols (letters or numbers), objects or colors as quickly as they can. RAN has been hypothesized to reflect at least partly the arbitrary mappings between orthography and phonology (Manis, Seidenberg, & Doi, 1999). Given that Chinese is a deep orthography in which sound – symbol correspondences are relatively opaque, as described earlier, RAN skills should presumably be important for reading in Chinese early on. Chinese reading is a process of mapping syllables to characters. Thus, syllable awareness as a level of phonological awareness should be particularly important in Chinese reading. Vocabulary knowledge, as a measure of general language skills, has been found to be a unique developmental predictor for all Chinese literacy skills as well (Pan et al., 2011).

In addition to the above-mentioned established cognitive and linguistic skills that are found to relate to Chinese word reading, a novel task was included in the present study to examine the correlates of early Chinese literacy, namely, semantic radical awareness (Lam & McBride-Chang, 2013). Semantic radical awareness refers to the sensitivity to morphemic structure of Chinese characters (Li, Anderson, Nagy, & Zhang, 2002; Shu & Anderson, 1997). For example, “木” is the semantic radical (meaning “wood”) in the compound character “松” (meaning “pine”). An early attempt to specify the role of semantic radical awareness in Chinese children’s literacy acquisition was made by Shu and Anderson (1997). They found that primary school children were aware of the relationship between semantic radical and character meaning. Additionally, semantic radical knowledge was found to be necessary for reading skill. Shu (2003) reported that primary-school-aged children could recognize the subcomponents of a given character before memorizing the whole character. Semantic radical knowledge depends on one’s learning experience. The present study further examined the role of semantic radical awareness in younger children’s concurrent and subsequent Chinese literacy development.

For Chinese word writing, correlates are less clear compared with Chinese word reading. In models of word reading and word writing in alphabetic orthographies, some (Bradley & Bryant, 1979; Goswami & Bryant, 1990) have proposed that there is a discrepancy and a separation between children’s reading and spelling in early development. Reading is often a poor predictor of spelling in young children, though spelling tends to explain reading (Bosman & Van Orden, 1997; Caravolas, Hulme, & Snowling, 2001). However, there are strong correlations between reading and spelling over time in alphabetic orthographies (Ehri, 1997). To what extent are early reading and writing processes in Chinese separable or overlapping? And how do early cognitive and linguistic skills contribute to reading and writing in the early childhood years? The most recent findings from the Early Childhood Longitudinal Study-Kindergarten (ECLS-K) and the National Assessment of Education Progress (NAEP) highlight the need for understanding writing development and developing writing interventions for both young children and disabled learners (Miller & McCardle, 2011).

Chinese writing is, to the beginner, a process of converting oral language to seemingly arbitrary visual forms without clear phonological cues. Learners should write each stroke according to the configurations of the characters. Such writing is complicated because stroke order is inflexible but nonintuitive to beginning learners; thus, much of writing mastery involves internalizing the visual-motor aspects of this writing (Kao, 2006).

Tan et al. (2005) asserted that copying of Chinese characters might facilitate children’s internalization of the visual-orthographic aspects of Chinese writing. Additionally, visual-motor integration can improve the formation of long-term motor memory of Chinese characters. By repeatedly copying, children may gradually attend to stroke order, which is essential for expert word representation in Chinese (Flores d’Arcas, 1994; Yeung, Ho, Chan, & Chung, 2013). Thus, copying practice might help children develop better spontaneous writing of correct forms of Chinese characters. Indeed, parents and educators typically emphasize rote learning of Chinese characters as the best way for children to learn to read and write in the initial learning stage (Li & Rao, 2005; Packard et al., 2006; Wu, Li, & Anderson, 1999).

Ziegler and Goswami (2005) talked about an inverse progression of orthographic and phonological development in their psycholin-guistic grain size theory. Chinese writing and reading stage models also capture this progression from small-to-large and large-to-small unit sizes. Children learn whole characters when they begin to read in Chinese; gradually they come to understand the function of smaller radicals within characters to help them read new characters (Ho, Yau, & Au, 2003; Shu, 2003). Chinese children’s writing units evolve from strokes to larger units of strokes (radicals) and logographs (the whole characters) (Shi, Li, Zhang, & Shu, 2011). Thus, copying skill, which can facilitate children’s memory for strokes and implicit knowledge of character structure, might be particularly important for acquiring writing in an early learning stage. Wang, McBride-Chang, and Chan (2013) found that copying skill was associated with word writing in Chinese kindergarteners. In the present study, we moved further to look at the association of word reading with writing, as well as the specific correlates of each, in Mainland Chinese kindergarteners. We included semantic radical awareness, which was not included in previous investigations, and copying skills.

We considered two types of copying skills that might be important for children’s early writing skill. One is “pure” copying of unfamiliar two-dimensional print of which children have no prior cognitive or orthographic experience or knowledge. This pure copying skill captures relatively pure integrated visual-motor skills relevant to Chinese writing and distinguished dyslexic and nondyslexic Hong Kong Chinese children in one study (McBride-Chang, Chung, & Tong, 2011). The other, visual-orthographic copying skill, combines visual-motor skill with visual-orthographic knowledge. Visual-orthographic knowledge in Chinese typically implies knowledge of the positions, structuring, and functions of the radicals within Chinese characters (McBride-Chang, Chung,
et al., 2011). One of the best methods for tapping this skill is via a task of delayed copying (Anderson et al., 2013).

To summarize, in the present study, we investigated the early development of both word reading and word writing in Chinese young children. We focused on two developmental questions. First, what are the unique cognitive and linguistic correlates of word reading and word writing, respectively, in Chinese young children? Second, how are these correlates related to subsequent reading and writing one year later? Answers to these questions will provide important evidence for the cognitive and linguistic skills needed for early literacy development and will shed light on facilitative instructional approaches for typically developing children and alternative teaching means for children with reading and/or writing difficulties.

Method

Participants

Participants were 73 native Chinese-speaking children (39 girls) from a public kindergarten in a middle-class area of Beijing, China; they completed all testing at both time 1 (T1) and a year later, at time 2 (T2). The mean age of the children at T1 was 5; 2 (year; month) (range = 4; 9–6; 2). In Mainland China, kindergarten normally lasts 3 years (K1, K2, and K3) beginning around age three and ends around age six. Formal literacy instruction is not provided until the children start primary school (Li & Rao, 2000). The kindergarten where the present study was conducted has eight classes in each grade. The children who participated in the present study were randomly selected from four classes of K2 and K3, respectively. Signed written parental consent was obtained from all participants. Originally at T1, 85 children were selected and completed T1 testing, but at T2, seven children had moved to other districts of the city for family reasons and were inaccessible, and five children were ill during testing. Among the 73 children in the final sample, 42 were from K2 and 31 were from K3. According to the home literacy questionnaires and the teacher reports completed prior to the study, all participating children were typically developing monolingual Mandarin Chinese speakers and no child had known developmental, speech, language, or behavior problems. All children were from middle-income families. The average level of mother education was 17.4 years (with 16 years being equivalent to a college degree).

Procedure

At T1, children received Chinese word reading and word writing tests and a battery of cognitive-linguistic tasks described below. Except for the delayed copying and pure copying tasks which were tested in a group format, all other tasks were administered individually. Testing typically lasted 20 min per session across three sessions and the order of tasks was randomized across children. At T2, children received Chinese word reading and word writing again. All testing instructions were given in Mandarin Chinese by trained graduate students of psychology or linguistics majors.

Measures

Nonverbal IQ

Raven’s Progressive Matrices (Raven, Court, & Raven, 1996) is a multiple-choice measure used to test children’s nonverbal intelligence. At T1, Sets A and B were administered to measure young children’s nonverbal reasoning ability. For each of the 24 items, children were asked to identify the missing element that completed a pattern from among six choices. The maximum score was 24 points and the internal consistency reliability for this task was .79.

Chinese word reading

At both T1 and T2, a Chinese word recognition task was used to examine children’s early reading ability. In this task, children were required to read 50 Chinese single-character words aloud one by one, and the characters were arranged according to approximate difficulty level. This task has been successfully used for this age range of children from Mainland China in the past research (Lin et al., 2010). One point was given per word and the maximum score was 50 points. The internal consistency reliability for this task was .98 at T1 and .92 at T2.

Chinese word writing

At both T1 and T2, a Chinese word dictation task was administered to assess children’s writing skills (Wang et al., 2013). Children were asked to write 10 orally familiar words (three single-character words and seven two-character words) selected from common story books in kindergarten and standard textbooks in primary schools. In order to avoid confusion across Chinese homophones in single-character words, the experimenter offered compound words consisting of the target single-character words for children’s reference. For example, children were asked to write the character “y” (meaning “cloud”) as in the word “yán” (meaning “white cloud”). One point was given for a correctly written character and the total score for this task was 17 points. The internal consistency reliability for this task was .77 at T1 and .84 at T2.

Semantic radical awareness

At T1, a semantic radical selection task was administered to test children’s semantic radical awareness. This task consisted of 15 semantic-radical items which were transparent in meaning: for example, “亻” always represents animals. For each item, children were asked to choose the best one out of four pictures that matched the meaning of the target semantic radical. This task has been used in previous research of Hong Kong children in this age range (Lam & McBride-Chang, 2013). One point was given for each correct answer and the maximum possible score was 15. The internal consistency reliability for this task was .70.

Visual-motor skill

At T1, we administered two copying tasks of unfamiliar scripts, including Korean and Hebrew words, to measure children’s visual-motor skill. Both of them were time-limited tasks, with children allotted 5 min to finish each task (McBride-Chang, Chung, et al., 2011). For Korean copying, children were asked to copy five Korean words arranged according to levels of visual difficulty on an answer sheet. Each Korean word consisted of three segments, and the scoring criteria included both the shape and position of each segment across a 3-point (0–2) scale. Zero (0) points were given for an incorrect shape or the shape in an incorrect position. One (1) point was given for a similar shape or the shape in a position close to the correct location, and two (2) points were awarded for a correct shape and the shape in the correct position. For Hebrew copying, children were required to copy five Hebrew words and each Hebrew word consisted of three to six segments. The coding system for the shape of each segment, sequence, and alignment of all segments within a word was scored on a 2-point (0–1) scale. Zero (0) points were given when children wrote an incorrect shape or produced the components in incorrect sequence, or created an incorrect alignment across components. One (1) point was given when children wrote a correct shape of the component, put the components in a correct sequence of components, and made all the components in a correct alignment. Both copying tasks were designed to tap copying of a sort the children had never done before because all stimuli were
completely unfamiliar; items were scored by research assistants unfamiliar with these scripts at all. Therefore, although the items that were copied were actually real Korean and Hebrew words, they were treated as relatively “pure” visual-motor skills items. The maximum possible score was 60 and 30 for Korean copying (with each word having a total possible score of 12) and Hebrew copying, respectively. Two Chinese research assistants with a degree in psychology scored the two copying tasks; neither had any knowledge of Korean or Hebrew scripts. The inter-rater reliability was .97 and .98 for Korean copying and Hebrew copying, respectively.

**Visual-orthographic copying skill**

At T1, we administered a delayed copying task to measure children’s visual-orthographic copying skill. The task consisted of five unfamiliar Chinese characters ranked according to increasing difficulty level. Each visual character was displayed for two seconds and then removed from view; children were then asked to write down the whole character from memory (Anderson et al., 2013; Pak et al., 2005). The time limit for each character was 1 min. Scores were given according to the accuracy and integration of each character across a 4-point (0–3) scale. The maximum score of three points was awarded when children wrote the correct character; two points were given when more than one components within the character could be identified; one point was given when only one component could be identified. Zero points were allotted when no Chinese character could be identified. Two Chinese research assistants with a degree in psychology scored the task. The maximum possible score for this task was 15 and the inter-rater reliability was .92.

**RAN for numbers**

At T1, we tested RAN for numbers rather than colors or other measures because RAN for numbers is a particularly strong correlate for literacy development in Chinese children (Liao, Georgiou, & Parrila, 2008). Children were asked to read aloud five single-digit numbers (5, 3, 1, 4, 8) placed in five rows and randomly ordered by row as quickly as possible. Children were first required to name the five numbers individually without being timed to ensure that most of them knew the names of the five numbers. Children were then encouraged to read aloud the 25 digits from top to bottom, from left to right, and the experimenter recorded the total time taken for this. The task was administered twice and the average of the two scores was used to represent a final naming speed measure (McBride-Chang et al., 2008). The test-retest reliability for this task was .81.

**Vocabulary knowledge**

At T1, a vocabulary definitions task adapted from the Stanford-Binet Intelligence Scale vocabulary subtest (Thordike, Hagen, & Sattler, 1986) was used to measure Mandarin-speaking children’s expressive vocabulary knowledge. Thirty-two vocabulary words ranked according to increasing difficulty levels were presented, and children were asked to provide oral definitions of the Chinese words presented by the experimenter. The answers were scored as either 0, 1 or 2 by referring to a standardized marking scheme. Two points were given for a synonym or a clear description of the target word; one point was given for an ambiguous answer or an example given to describe the target word; and no points were given for repetition of the target word or a wrong description. Testing stopped when the children failed to give the correct answer across five consecutive words. The maximum possible score was 64. The internal consistency reliability for this task was .95.

**Morphological awareness**

At T1, a morphological construction task was used to measure children’s morphological awareness. The task has been successfully used in previous studies in Mainland China (Lei et al., 2011; Liu & McBride-Chang, 2010). In this task, children were asked to come up with labels for 27 new objects or concepts by combining familiar morphemes using conventional language structure. For example, “[What would we call a type of oil that is made using peanuts? The correct answer would be mushroom oil].” One point was given for the correct item, and the total score was 27. The internal consistency reliability for this task was .85.

**Phonological awareness**

At T1, a syllable deletion task was used to test children’s phonological awareness. Twelve three-syllable Mandarin phrases were orally presented by an experimenter, and the children were asked to delete one of the syllables in each phrase and then to say the new phrase following this deletion (Shu et al., 2008). One point was given for a correct answer. The maximum possible score for this task was 12 and the internal consistency reliability was .87.

**Results**

Reliabilities for all tasks were reasonable, all at or above .70. The means, standard deviations, and ranges for all variables separately for T1 and T2 are displayed in Table 1. At T1, children had relatively low scores on word reading, writing and visual-orthographic copying tasks. The means of these three tasks were all below one third of the total score of each task.

Table 2 shows all correlations among included variables at T1 and T2 separately. After statistically controlling age and IQ, word reading and writing were not significantly correlated at T1; however, at T2, reading and writing became moderately and significantly associated with one another. Chinese reading was significantly correlated with semantic radical awareness, RAN, and vocabulary knowledge across T1 and T2. In addition, at both T1 and T2, Chinese writing was significantly correlated with visual-orthographic copying skill, but Chinese reading was not. At T1, both visual-orthographic copying and visual-motor skill tasks were significantly and moderately associated with Chinese writing, whereas after twelve months, only visual-orthographic copying was significantly associated with Chinese writing. In contrast, significant correlates of Chinese reading at T1 were semantic radical awareness, RAN and vocabulary knowledge only, and at T2, were semantic radical awareness, RAN, vocabulary knowledge, morphological awareness, and phonological awareness.

To examine the unique correlates of reading and writing, we conducted stepwise regression analyses separately for word reading and word writing at T1, with all significant correlates from Table 2 included. Because we sought to understand unique correlates of word reading and writing, we statistically controlled each in the analyses for explaining the other (i.e., word writing was statistically controlled when word reading was the dependent variable, and vice versa).

For T1 word reading, because age and IQ were significantly associated with word reading, we first controlled age, IQ, and T1 word writing, and then used stepwise analysis to find out the unique correlates of T1 word reading. As indicated in Table 3, with age, IQ, and T1 writing skill statistically controlled, semantic radical awareness, RAN, and vocabulary knowledge explained 15%, 6%, and 3% unique variance in Chinese reading, respectively.

For T1 word writing, similarly, we first controlled age, IQ, and T1 word reading, and then used stepwise analysis to find the unique
Table 1
Means, standard deviations and ranges for all variables at time 1 and time 2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time 1 (N=85)</th>
<th>Time 2 (N=73)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>Age</td>
<td>61.58 (6.07)</td>
<td>49–74</td>
</tr>
<tr>
<td>IQ (Nonverbal IQ)</td>
<td>13.35 (3.98)</td>
<td>4–24</td>
</tr>
<tr>
<td>Chinese reading</td>
<td>13.08 (12.91)</td>
<td>0–45</td>
</tr>
<tr>
<td>Chinese writing</td>
<td>4.76 (3.21)</td>
<td>0–16</td>
</tr>
<tr>
<td>RAN</td>
<td>20.33 (7.08)</td>
<td>7.26–45.55</td>
</tr>
<tr>
<td>Vocabulary knowledge</td>
<td>15.36 (8.08)</td>
<td>0–36</td>
</tr>
<tr>
<td>Semantic radical awareness</td>
<td>9.24 (3.05)</td>
<td>1–15</td>
</tr>
<tr>
<td>Morphological awareness</td>
<td>18.05 (4.63)</td>
<td>0–24</td>
</tr>
<tr>
<td>Syllable deletion</td>
<td>8.45 (3.30)</td>
<td>0–12</td>
</tr>
<tr>
<td>Visual-orthographic copying</td>
<td>4.48 (3.43)</td>
<td>0–15</td>
</tr>
<tr>
<td>Korean copying</td>
<td>50.18 (10.33)</td>
<td>12–60</td>
</tr>
<tr>
<td>Hebrew copying</td>
<td>23.34 (6.61)</td>
<td>0–30</td>
</tr>
</tbody>
</table>

Note: Only Chinese word reading and word writing were tested at both time 1 and time 2, and other measures were only administered at time 1.

Table 2
Pearson correlations among all variables at time 1 (across) and time 2 (down) after controlling for age and IQ.

<table>
<thead>
<tr>
<th>CR</th>
<th>CW</th>
<th>RAN</th>
<th>VK</th>
<th>SA</th>
<th>MA</th>
<th>SD</th>
<th>VoC</th>
<th>KC</th>
<th>HC</th>
<th>PVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese reading (CR)</td>
<td>–</td>
<td>.20</td>
<td>−.43</td>
<td>.39</td>
<td>.48</td>
<td>.23</td>
<td>.22</td>
<td>.19</td>
<td>.13</td>
<td>.14</td>
</tr>
<tr>
<td>Chinese writing (CW)</td>
<td>.61</td>
<td>−</td>
<td>.10</td>
<td>.15</td>
<td>.16</td>
<td>.14</td>
<td>.18</td>
<td>.14</td>
<td>.54</td>
<td>.34</td>
</tr>
<tr>
<td>RAN</td>
<td>−.47</td>
<td>−.23</td>
<td>−.10</td>
<td>.15</td>
<td>.16</td>
<td>.14</td>
<td>.18</td>
<td>.14</td>
<td>.54</td>
<td>.34</td>
</tr>
<tr>
<td>Vocabulary knowledge (VK)</td>
<td>.29</td>
<td>−</td>
<td>−.21</td>
<td>−.50</td>
<td>−.38</td>
<td>−.43</td>
<td>−.25</td>
<td>−.32</td>
<td>−.24</td>
<td>−.30</td>
</tr>
<tr>
<td>Semantic radical awareness (SA)</td>
<td>.57</td>
<td>−</td>
<td>−.20</td>
<td>.18</td>
<td>.03</td>
<td>.10</td>
<td>.04</td>
<td>.09</td>
<td>.03</td>
<td>.01</td>
</tr>
<tr>
<td>Morphological awareness (MA)</td>
<td>.28</td>
<td>−</td>
<td>−.38</td>
<td>.34</td>
<td>.30</td>
<td>.20</td>
<td>.17</td>
<td>.20</td>
<td>.17</td>
<td>.34</td>
</tr>
<tr>
<td>Syllable deletion (SD)</td>
<td>.26</td>
<td>.24</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Visual-orthographic copying (VoC)</td>
<td>.22</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Korean copying (KC)</td>
<td>.23</td>
<td>.23</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Hebrew copying (HC)</td>
<td>.15</td>
<td>.15</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Pure visual-motor factor (PVF)</td>
<td>.20</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
</tbody>
</table>

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

Table 3
Multiple stepwise regression explaining children’s Chinese reading at time 1 with children’s nonverbal IQ, age and time 1 writing skill controlled.

<table>
<thead>
<tr>
<th>Block and variables</th>
<th>R² change</th>
<th>R² change</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.23</td>
<td>.23*</td>
<td>−.28</td>
<td>.23</td>
<td>−.13</td>
</tr>
<tr>
<td>IQ</td>
<td>.31</td>
<td>.43</td>
<td>.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 writing skill</td>
<td>.12</td>
<td>.28</td>
<td>.47</td>
<td>.30*</td>
<td></td>
</tr>
<tr>
<td>Block 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic radical awareness</td>
<td>.38</td>
<td>.15*</td>
<td>.128</td>
<td>.47</td>
<td>.30*</td>
</tr>
<tr>
<td>Block 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary knowledge</td>
<td>.44</td>
<td>.06*</td>
<td>.37</td>
<td>.14</td>
<td>.23</td>
</tr>
<tr>
<td>Block 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAN</td>
<td>.47</td>
<td>.03*</td>
<td>−.46</td>
<td>.20</td>
<td>−.26</td>
</tr>
</tbody>
</table>

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

correlates of T1 word writing. Given that the two copying tasks of Korean and Hebrew were intended to measure relatively pure visual-motor skill and that they were relatively highly associated, an exploratory factor analysis was performed first on these two tasks. The results showed that only one factor with Eigen value > 1.0 (λ = 1.782) emerged from this analysis, and it explained about 89% of the variance in the two copying tasks. Moreover, the communalities of the variables in this analysis were all above 0.8. Therefore, we extracted this one common factor underlying copying skill, which was significantly associated with children’s T1 word writing (see Table 2), and used the factor score to represent “pure” visual-motor skill in subsequent stepwise analysis. As indicated in Table 4, with age, IQ, and T1 reading skill statistically controlled, only visual-orthographic copying explained 20% of unique variance in T1 word writing.

We then examined the longitudinal predictors of T2 word reading and word writing. For T2 word reading, we first controlled age, IQ, and T1 word reading, and then used stepwise analysis to find out the unique correlates of T2 word reading. As indicated in Table 5, with age, IQ and T1 reading skill statistically controlled, only semantic radical awareness contributed 3% unique variance in T2 word reading. Similarly, for T2 word writing, as indicated in Table 6, with age, IQ, and T1 writing skill statistically controlled, only semantic radical awareness contributed 4% unique variance in T2 word writing.

Discussion
Given the importance of early literacy development for all school learning, we explored early indicators of word reading and word writing skills in young Chinese children in the present study. Our study examined the unique correlates of word reading and writing in 4–6-year-old Chinese children and their relationship with subsequent reading and writing ability one year later.

We found that, initially, word reading and writing in Chinese were not strongly related. However, these skills became moderately and significantly associated with one another one year later. The two skills were, thus, surprisingly separate in early
development, but became related to each other in later development. At T1, children appeared to make use of different cognitive-linguistic skills in learning to read and write. The unique correlates of word reading were semantic radical awareness, RAN, and vocabulary with age, nonverbal reasoning, and word writing statistically controlled, whereas the only unique correlate of Chinese word writing was visual-orthographic copying skill with age, nonverbal reasoning and word reading statistically controlling. Semantic radical awareness was a significant longitudinal predictor for both word reading and writing in Chinese with age, nonverbal reasoning, and T1 performance statistically controlled. These findings suggest that Chinese word reading and writing differ in unique correlates in the early years, but semantic radical awareness was a significant and longitudinal predictor of both reading and writing skills.

**Unique correlates of word reading and writing**

In early literacy, reading is defined as word recognition, involving recognition memory; writing requires the production of words to be read. In the present study, writing skills were not correlated with reading skills at T1, with age and nonverbal reasoning statistically controlled. We found unique and non-overlapping correlates of reading even beyond writing, and vice versa. The results showed that young Chinese children at the initial stage of literacy learning appear to make use of different skills in learning to read and write. This was consistent with the finding of an early separation between children’s reading and spelling in English (Bradley & Bryant, 1979; Goswami & Bryant, 1990). There are two possible explanations for the discrepancy we found between early reading and writing in Chinese in the present study. First, at the general level, young children have little learning experience and limited literacy knowledge. They may not transfer important cognitive and linguistic skills across tasks in the learning process in the early stage. Second, at the specific level, Chinese is morphosyntactic in nature and features high visual complexity. Consequently, learning to read and write in Chinese may need more efforts in the beginning than learning to read and write in alphabetic languages, making cross-task transfer of resources even harder. This is evidenced by the non-overlapping unique correlates of Chinese word reading and writing at T1, as detailed below.

For Chinese word reading, vocabulary knowledge, RAN, and semantic awareness emerged as unique correlates. As shown in previous work with older Mainland Chinese children (Pan et al., 2011; Shu et al., 2006), RAN and vocabulary knowledge were uniquely associated with Chinese word reading. Knowledge of word meaning (vocabulary knowledge) is particularly helpful for mappings between visual forms and oral language in children's lexical system. RAN taps the arbitrary links of symbols to spoken language, and thus should be especially important for Chinese reading because of the opaque orthography. More interestingly, we also found that the newly introduced semantic radical awareness task was uniquely associated with Chinese word reading at T1. This meaning-related skill is seldom investigated when exploring early reading development. The contribution of semantic radical awareness to reading development, even among very young children, is a novel finding in the area of word reading in Chinese. The knowledge of semantic radicals, which provide information about a character’s meaning, typically gives a clue to help children to recognize characters. Large groups of Chinese characters share the same semantic radicals, and they are directly or indirectly related in meaning. Semantic radical awareness, thus, might enable young children to remember familiar characters and learn unfamiliar characters. The strength of its relations with Chinese word reading confirms the particular role of semantic radical awareness in young children’s early reading development. Comparatively, in alphabetic languages, letter-name knowledge, phonological awareness, and RAN have been found to be correlated with beginning reading skills in both correlational and longitudinal studies (Foulon, 2005; McBride-Chang et al., 2013; Muter, Hulme, Snowling, & Stevenson, 2004; Pan et al., 2011), and the predictors of reading performance were relatively universal among alphabetic languages (Ziegler et al., 2010). Thus, the results of the present study revealed both universal and unique correlates of Chinese and alphabetic word reading among young children. Specifically, RAN was revealed as a unique correlate of both Chinese and alphabetic word reading, whereas semantic radical awareness and vocabulary knowledge emerged as unique correlates of Chinese word reading only.

For Chinese word writing, visual-orthographic copying skill, focusing on both visual-motor integration and orthographic knowledge, emerged as the only unique correlate. Visual-orthographic copying skill should be especially more important in learning to write Chinese in the early stage. In alphabetic languages, words are formed from a fixed set of symbols (typically 22–30 letters of the alphabet), but in Chinese, the majority of the thousands of characters were formed from over 1290 radicals, which may be further divided into about 648 subcomponents (Fu, 1989). Moreover, radicals should be positioned properly according to Chinese orthographic rules. Thus, to write a character correctly, young children not only need to possess proper visual motor skills to integrate strokes into radicals and then into whole characters, but also need to know which radicals to use and how to place them legally. All these skills were tapped simultaneously in the single task of visual-orthographic copying in our study. In alphabetic writing systems, phonological awareness, RAN, and letter knowledge were the core component skills underlying spelling development (Caravolas, 2004; Furnes & Samuelsen, 2011; Georgiou, Torppa, Manolitsis, Lyytinen, & Parrila, 2012; Li, McBride-Chang, Wong, & Shu, 2012). Contrastingly, the results of the present study demonstrated the unique role of visual-orthographic copying in Chinese word writing. These results support the idea that copying practice might facilitate better spontaneous writing skill and provide a memory aid for reproduction of correct forms of Chinese characters. To some extent, visual-orthographic copying might best capture the visual-orthographic and motor skills involved in Chinese writing activity. Taken together, Chinese word reading and writing appear to be relatively separated processes and differ in unique correlates in

---

**Table 5**

Multiple stepwise regression explaining children's Chinese reading at time 2 with children's nonverbal IQ, age and time 1 reading skill controlled.

<table>
<thead>
<tr>
<th>Block and variables</th>
<th>R²</th>
<th>R² change</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.76</td>
<td>.76**</td>
<td>.36</td>
<td>.15</td>
<td>.16*</td>
</tr>
<tr>
<td>Nonverbal IQ</td>
<td>.32</td>
<td>.22 .09</td>
<td>.63</td>
<td>.07</td>
<td>.64**</td>
</tr>
<tr>
<td>T1 reading skill</td>
<td>.96</td>
<td>.30 .22</td>
<td>.79</td>
<td>.03</td>
<td>.79**</td>
</tr>
<tr>
<td>Block 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic radical awareness</td>
<td>.58</td>
<td>.58**</td>
<td>.12</td>
<td>.06</td>
<td>.21*</td>
</tr>
<tr>
<td>Nonverbal IQ</td>
<td>.10</td>
<td>.07 .11</td>
<td>.50</td>
<td>.10</td>
<td>.47**</td>
</tr>
<tr>
<td>T1 writing skill</td>
<td>.62</td>
<td>.04 .22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

---

**Table 6**

Multiple stepwise regression explaining children's Chinese writing at time 2 with children's nonverbal IQ, age and time 1 writing skill controlled.

<table>
<thead>
<tr>
<th>Block and variables</th>
<th>R²</th>
<th>R² change</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.58</td>
<td>.58**</td>
<td>.12</td>
<td>.06</td>
<td>.21*</td>
</tr>
<tr>
<td>Nonverbal IQ</td>
<td>.10</td>
<td>.07 .11</td>
<td>.50</td>
<td>.10</td>
<td>.47**</td>
</tr>
<tr>
<td>T1 writing skill</td>
<td>.62</td>
<td>.04 .22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05.  
** p < .01.
the early years. Semantic radical awareness, RAN, and vocabulary knowledge tend to be more closely related to children’s early reading skills. Given the morphonesyllabic nature of the Chinese writing system, children might rely more on meaning-related knowledge when they learn to recognize and memorize new characters. In contrast, visual-orthographic copying skill emerged as the only significant correlate of word writing. Visual–orthographic copying skill likely not only facilitates children’s long-term memory memory for Chinese characters, but also contributes to overall orthographic knowledge (Packard et al., 2006; Tan et al., 2005), which further facilitates writing development (Li et al., 2006; Tong et al., 2009).

Longitudinal predictors of word reading and writing

Finally, word reading and writing became strongly associated with one another over time, suggesting rapid changes in early Chinese literacy development. As several studies have suggested, Chinese writing skills are highly correlated with reading scores in older children or adults (Pak et al., 2005; Tan et al., 2005), similar to English (Ehri, 1997). The present study showed moderate and significant association between Chinese word reading and writing at T2.

The other novel contribution of the present study was the important role of semantic radical awareness in subsequent reading and writing development. As shown in Tables 5 and 6, semantic radical awareness emerged as a unique correlate of both reading and writing one year later. The development of semantic radical awareness, which reflects Chinese kindergartners’ sensitivity to the formal and functional characteristics of radicals, seems to be very important to Chinese literacy development. Children’s semantic radical awareness and Chinese reading and writing might reinforce each other in the early years. Semantic radical knowledge provides meaning-related cues to assist children in reading and writing Chinese characters. Those who can read and write some characters may be more likely to notice patterns in semantic radicals; they can then make use of these radicals to learn more characters. The results also showed that, beyond word reading and writing, semantic radical awareness was also associated with RAN, morphological awareness and phonological awareness, which have been found to be related to Chinese literacy development. Thus, the findings suggest that semantic radical awareness could be emphasized in Chinese literacy learning, even during the early childhood years.

Limitations and directions for future study

There were three major limitations in this study. First, some of the tasks were relatively difficult for kindergartners. Because the children included were beginners in learning Chinese and had relatively little literacy experience, word reading, writing, and visual–orthographic copying tasks may have been somewhat difficult for them to complete, especially at T1. Second, the sample size was relatively small and homogeneous in SES composition (middle-class) and geographical background (urban). The relatively small and homogeneous sample might limit the generalizability of the findings to a larger population. In future studies, a larger sample with different SES levels and geographical backgrounds may be needed to further explore the concurrent and longitudinal predictors of early Chinese literacy skills as well as the individual differences in early Chinese literacy development. Third, it should be noted that the unique correlates of early Chinese reading and writing skills were obtained from a design that was correlational by nature; thus, a causal relationship between these skills awaits further investigations.

Conclusion and implications

The early childhood years are critical for children in acquiring fundamental language and literacy skills. The findings of the present study provide evidence for early developmental differences in the acquisition of reading and writing in Chinese kindergartners. Theoretically, Chinese word reading and writing development were broadly consistent with the models of alphabetic orthographies. We found that there is a separation between Chinese reading and writing in early development and that beginning learners make use of different skills in learning to read and write in Chinese. However, word reading and writing gradually become closely related over time. Practically, these findings suggest that vocabulary knowledge, semantic radical awareness, and visual-motor related skills are uniquely related to Chinese literacy learning in the initial stage and thus could be emphasized during early childhood. The longitudinal nature of the present study also underscores the importance of semantic radical awareness for both reading and writing development. It suggests that teachers and parents could draw more children’s attention to semantic radical knowledge in Chinese, which may facilitate children’s literacy development in the long term. This longitudinal research sheds light on the theoretical underpinnings of early reading and writing development and potentially suggests ways to improve early literacy instruction and early detection of children at risk for reading and/or writing difficulties.

Acknowledgements

This research was supported by National Natural Science Foundation of China Grant (81371497) and Tsinghua University Initiative Scientific Research Program (20121088017). We thank all participating children, and Sun Yuting and Wei Liwei for their help in data collection. We also thank the editor and three anonymous reviewers for very helpful suggestions on an earlier version of this article.

References


http://dx.doi.org/10.1080/10888430903162910


