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Chinese children's early knowledge about writing

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Much research on literacy development has focused on learners of alphabetic writing systems. Researchers have hypothesized that children learn about the formal characteristics of writing before they learn about the relations between units of writing and units of speech. We tested this hypothesis by examining young Chinese children's understanding of writing. Mandarin-speaking 2- to 5-year-olds completed a graphic task, which tapped their knowledge about the formal characteristics of writing, and a phonological task, which tapped their knowledge about the correspondence between Chinese characters and syllables. The 3- to 5-year-olds performed better on the graphic task than the phonological task, indicating that learning how writing appears visually begins earlier than learning that writing corresponds to linguistic units, even in a writing system in which written units correspond to syllables.

Statement of contribution

What is already known on this subject?

- Learning about writing's visual form, how it looks, is an important part of emergent literacy.
- Knowledge of how writing symbolizes linguistic units may emerge later.

What does this study add?

- We test the hypothesis that Chinese children learn about writing's visual form earlier than its symbolic nature.
- Chinese 3- to 5- year-olds know more about visual features than character–syllable links.
- Results show learning of the visual appearance of a notation system is developmentally precocious.

Learning to understand and use symbol systems is an important part of cognitive development. Symbols have an inherently dual nature: They are objects in their own right and they represent something other than themselves. Children need to think about and mentally represent both aspects (DeLoache, 2011). Understanding the relation between a symbol and its referent can be challenging, as in the learning of such symbol systems as maps and scale models (DeLoache, 1991, 2000). In the present study, we focused on another symbol system, writing. Writing, like other symbol systems, has two aspects. The first is its outer form: what it looks like on the surface. For example, writing is made up of marks arranged in a linear fashion. The second aspect of writing is its inner structure: how

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the marks symbolize units of language. We examined knowledge of these two aspects of writing in 2- to 5-year-old children exposed to the Chinese writing system.

Our understanding of children's early knowledge of writing, or emergent literacy, has been informed primarily by research on learners of alphabetic systems (Ferreiro & Teberosky, 1982; Tolchinsky, 2003; Treiman & Kessler, 2014). Drawing on evidence from such research, several researchers (Bialystok & Martin, 2003; Tolchinsky Landsmann & Karmiloff-Smith, 1992) have hypothesized that with writing, as with other symbol systems, children consider notations for their own sake before understanding that they symbolize something outside themselves. Thus, children begin to learn about the outer form of writing from an early age, prior to learning about its inner structure. A number of findings support the idea that children exposed to alphabetic writing systems learn about some of the salient formal characteristics of writing from an early age (e.g., Ferreiro & Teberosky, 1982; Ganopole, 1987; Lavine, 1977; Levy, Gong, Hessels, Evans, & Jared, 2006; Tolchinsky Landsmann & Levin, 1985; Treiman, Cohen, Mulqueeny, Kessler, & Schechtman, 2007; Treiman, Mulqueeny, & Kessler, 2014). For example, Lavine (1977) showed 3-, 4-, and 5-year-old English-speaking children displays containing letters of the Latin alphabet and displays containing symbols from other writing systems and asked them whether each display was writing. Even children in the youngest group (age range 3;0 [years; months] to 4;1) accepted Latin letters as writing more often than visually dissimilar foreign symbols such as Chinese characters. Similarly, Treiman *et al.* (2007) found that U.S. children with a mean age of 3;7 performed well at picking displays made up of Latin letters versus displays made up of symbols from Indian scripts as writing.

Although children exposed to alphabetic writing systems begin learning about the outer form of writing as early as 3 years of age, it often takes several years longer for them to learn how the units of writing symbolize phonemes. For example, Rozin, Bressman, and Taft (1974) presented U.S. kindergarteners with pairs of words with different numbers of letters (e.g., *mow* vs. *motorcycle*) and asked them which written word corresponded to a specific spoken word (e.g., /mo/). If children had some understanding that letters symbolize sounds, they would pick the long written word for the long spoken word and the short written word for the short spoken word. However, most of the kindergarteners chose one of the two displays at random. Similar findings were reported in other studies of English-speaking (Bialystok, 1991) and Swedish-speaking (Lundberg & Tornéus, 1978) children who had not begun formal literacy instruction.

A lack of understanding of writing's inner structure also reveals itself in preschoolers' attempts to write words. Many 3- to 5-year-olds do not use letters to represent phonemes and do not even use more letters to write phonologically longer words than phonologically shorter words (Pollo, Kessler, & Treiman, 2009 for learners of English and Portuguese; Zhang & Treiman, 2015 for learners of English). Children who are unable to spell in a phonological sense tend to use letters and letter groups that are common in their writing system, however, showing an implicit sensitivity to its visual patterns (Kessler, Pollo, Treiman, & Cardoso-Martins, 2013; Pollo *et al.*, 2009).

The findings we have reviewed with learners of alphabetic writing systems support the hypothesis that learning about the inner structure of writing lags behind learning about its outer form (Bialystok & Martin, 2003; Tolchinsky Landsmann & Karmiloff-Smith, 1992). Learning about the inner structure of writing may be difficult for children exposed to alphabetic systems because the basic units of writing in these systems, letters, correspond to phonemes. Phonemes, as studies show (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974; Treiman & Zukowski, 1991), are difficult for young children to abstract and process. A better test of the hypothesis that children begin to learn about the outer form of writing

earlier than they learn about its symbolic function would involve a writing system in which the basic units correspond to more accessible units of language. Chinese is such a system in that, with very few exceptions, each character maps onto a syllable (DeFrancis, 1989). In turn, each syllable in spoken Chinese almost always corresponds to a morpheme, the smallest meaningful unit of language. Children's ability to recognize and manipulate sound units develops earlier for syllables than phonemes (e.g., Demont & Gombert, 1996; Durgunoglu & Oney, 1999; Liberman *et al.*, 1974; Treiman & Zukowski, 1991), and Chinese children develop a sensitivity to syllables well before formal literacy instruction begins (e.g., Li, Shu, McBride-Chang, Liu, & Peng, 2012; McBride-Chang & Kail, 2002; Shu, Peng, & McBride-Chang, 2008). In Shu *et al.*'s study, in fact, even 3-year-old Chinese children performed above the level expected by chance on a forced-choice spoken syllable awareness task. Given the accessibility of syllables, Chinese provides a good test for the hypothesis that learning about the inner structure of writing lags behind learning about its outer form.

Only a few studies have examined young Chinese children's knowledge of the outer form and inner structure of their writing system. With regard to outer form, we know of only one study to have tested Chinese-speaking children younger than 5 years. In this study, Qian, Song, Zhao, and Bi (2015) asked 3- to 5-year-olds whether various displays, including common Chinese characters, pictures, and English words, were well-written Chinese characters. Qian *et al.* reported that even 3-year-olds rejected pictures and English words above the level expected by chance. However, the researchers did not separately analyse children's responses to these two types of items. Children's ability to differentiate Chinese symbols from foreign symbols is thus not clear. Moreover, the Chinese items included common characters and characters with common components that recur in different characters, or radicals. Children could have made their decisions based on familiarity with specific characters or radicals rather than knowledge of the general graphic characteristics of Chinese writing.

Studies of Chinese children's knowledge of their writing system's inner structure are also sparse. Apart from several case studies (Buckwalter & Lo, 2002; Chan, Cheng, & Chan, 2008), we know of only one study that has touched on this issue. In that study, in which 3- to 5-year-old Hong Kong children were asked to write their name, Chan and Louie (1992) found that the majority of 5-year-olds used as many characters as there were syllables in the name. Most of the 3- and 4-year-olds did not do this. This result suggests that Chinese children do not understand that each character should represent a syllable until about 5 years. However, the name was the only item that children were asked to write, and correct production of characters requires a high level of motor skill.

In the present study, we tested Chinese children's knowledge about the outer form of Chinese writing using a *graphic task* in which children were asked which of two displays, one with Chinese symbols and the other foreign symbols, was how people wrote a word. We used Kannada, which Chinese children are highly unlikely to have encountered, as the foreign script. As it looks quite different from Chinese, it allows for a good test of children's earliest knowledge about visual distinctions between Chinese and other writing systems. The Chinese characters in our study were low in frequency, and they contained relatively rare radicals. Ability to discriminate them from Kannada forms would thus point to knowledge about general graphic characteristics of Chinese rather than familiarity with specific characters or radicals. To test Chinese children's knowledge about the inner structure of writing, specifically that each character represents a syllable, we used a *phonological task* in which we showed children pairs of displays. One display contained one character and the other two characters. Children were asked which of the two

displays corresponded to a specified spoken word, which contained either one syllable or two. If Chinese children perform better on the graphic task than the phonological task, this would support the hypothesis that children begin to learn about the outer form of writing before learning about its inner structure (Bialystok & Martin, 2003; Tolchinsky Landsmann & Karmiloff-Smith, 1992), even in a writing system in which the basic visual units correspond to syllables.

Method

Participants

We tested 84 monolingual speakers of Mandarin (the standard spoken Chinese used in mainland China) who attended a public educational institution in a middle-class area of Beijing for children before the age of entry to primary school. Children were assigned to classes according to their age at entry into the class. We tested children from classes for 2-, 3-, 4-, and 5-year-olds. Table 1 shows the characteristics of the children at each level. The children were exposed to print, as in storybooks, but did not receive formal literacy instruction at school.

Procedure

Each child completed the two tasks in two sessions that were, on average, 9 days apart. Half of the children completed the graphic task in the first session and the other half completed the phonological task in the first session. The children were tested individually in a quiet location of their school. The same procedure was used for the graphic task and the phonological task. The tasks were presented with the aid of a puppet. Children first completed practice trials. Erroneous responses on these trials, which were rare, were corrected. For test trials, the experimenter explained that the puppet needed to be taught how people wrote and provided several examples of situations in which they write, such as writing their names. The experimenter then placed two cards on the desk and asked children which of the two displays corresponded to a particular spoken word. Children were asked to keep the card with writing on the desk and to put the other card in a trash can. Children were not told the correct answer when they responded incorrectly on test trials. To maintain children's interest, a filler trial was included after every four test trials. Each child had a different randomized order of the trials.

Stimuli

The written stimuli included 36 characters that are not taught in Chinese elementary schools (Shu, Chen, Anderson, Wu, & Xuan, 2003). We used simplified characters, which are used in mainland China, instead of traditional characters, which are used in Hong Kong

Table 1. Characteristics of children

Class	Total number	Number of girls	Age (range, *SD*)
2-year-old	20	9	2;9 (2;5–3;3, 0;3)
3-year-old	21	10	3;9 (3;3–4;3, 0;4)
4-year-old	22	12	4;8 (4;3–5;1, 0;3)
5-year-old	21	9	5;8 (5;3–6;1, 0;3)

and Taiwan. The characters were of low frequency, with a mean of five occurrences per million characters (Dictionary of Chinese Character Information, 1988, as cited in Shu *et al.*, 2003). Twenty-four of the selected characters were simple characters (e.g., 爿 'chopped wood'), which cannot be divided into radicals. Because such characters can appear as components of other characters (e.g., 牒 'bed frame'), we ensured that the frequency with which each simple character appears as a component of common characters is low (mean frequency = 9.83 of 3,500 common characters, china-language.gov.cn). The other 12 characters were compound characters (e.g., 殇 'to pass away at a young age'), which consist of two or more radicals. For these characters, the frequency with which each radical appears in common characters (e.g., 歹 'bad' also appears in 残 'injury') is also low (mean frequency = 29.92 of 3,500 common characters, china-language.gov.cn). In a pilot study, 15 children with a mean age of 6;5, older than the participants of the study, could not read any of the selected characters.

For the spoken stimuli, we selected eight one-syllable and eight two-syllable Mandarin spoken words that were thought to be highly familiar to young children, such as /t^{h}aŋ˥˩/ 'candy' and /p^{h}u˥ t^{h}au/ 'grapes'. Children are not taught about the characters representing these spoken words until they are in grade three, on average (Shu *et al.*, 2003).

Graphic task

We randomly selected characters from the set of low-frequency characters to form eight one-symbol Chinese displays (e.g., 冬) and eight two-symbol Chinese displays (e.g., 甫爻). Similarly, we created eight Kannada displays with each of one symbol (e.g., ಣ) and two symbols (e.g., ಛಶ). Each Chinese display was randomly paired with a Kannada display that contained the same number of symbols. The displays in each pair were approximately equal in size. The displays were printed on 6 cm × 12 cm cards. The position of card and type of writing (Chinese or Kannada) were counterbalanced. A randomly selected one-syllable spoken word from our set of spoken stimuli was presented together with each one-symbol display pair. A randomly selected two-syllable spoken word was presented together with each two-symbol pair. The Appendix shows the written and spoken stimuli.

Phonological task

We created 16 two-symbol displays (e.g., 戎走) using 32 characters from the set of low-frequency characters. Each two-symbol display was paired with a one-symbol display that was the first symbol of the two-symbol display (e.g., one pair included 戎走 and 戎). The displays were printed on 6 cm × 12 cm cards. The cards were placed on a desk, with one card closer to the child than the other. The position of card placement and number of symbols were counterbalanced. Half of the pairs were presented with a one-syllable spoken word, which was randomly selected from our set of spoken stimuli, and the other half of were presented with a randomly selected two-syllable spoken word. The visual displays and the corresponding spoken items are shown in the Appendix.

Both the phonological task and the graphic task had two practice trials, each of which involved an image of an edible object and another of a non-edible object. Both tasks also included four filler trials. The stimuli for each filler trial were two pictures of common objects. On filler and practice trials, children were asked which of the two objects served a particular purpose (e.g., which of a bed and a table was better for sleeping).

Table 2. Mean proportions and standard deviations of correct choices

Class	Graphic task	Phonological task
2-year-old	.45 (.42)	.51 (.51)
3-year-old	.83 (.22)***	.72 (.28)***
4-year-old	.90 (.16)***	.84 (.24)***
5-year-old	.98 (.06)***	.93 (.15)***

Note. ***$p < .001$ for difference from the chance level of .50 according to two-tailed binomial test.

Results

Table 2 shows the proportion of trials on which children of each class level chose the correct answer in the graphic and phonological tasks. Although children in 2-year-old classes performed poorly on both tasks, children in 3-, 4-, and 5-year-old classes responded correctly on the majority of the trials. These children chose the correct response more often in the graphic task than in the phonological task. To confirm these observations, we conducted generalized linear mixed-effects analyses with a logit link function using the R software package lme4 (Bates *et al.*, 2014). Children's age (in months) was centred at the grand mean. We included subject and display pair as random factors in the mixed-effects analyses. Our first model included age, task (graphic vs. phonological, with the graphic task being coded as 0 and the phonological task 1), and the interaction of age and task as fixed effects. Age had a significant effect on children's response accuracy ($\beta = .14$, $SE = 0.01, p < .001$), such that older children were more likely to respond correctly than younger children. Task was significantly associated with response accuracy ($\beta = -.78$, $SE = 0.21$, $p < .001$), such that children were more likely to respond correctly in the graphic task than the phonological task. The interaction of age and task was also significant ($\beta = -.05$, $SE = 0.01, p < .001$).

To examine the interaction between age and task, we conducted follow-up analyses for children at each class level. For children in 2-year-old classes, there was no significant effect of task ($p = .33$); performance did not differ significantly from the chance level of .50 according to two-tailed binomial tests ($p = .082$ for the graphic task; $p = .867$ for the phonological task). For children in 3-, 4-, and 5-year-old classes, correct responses were significantly more common in the graphic task than the phonological task ($\beta = -.82$, $SE = 0.21, p < .001$ for the 3-year-old class; $\beta = -.71$, $SE = 0.25, p = .004$ for the 4-year-old class; $\beta = -1.46$, $SE = 0.49$, $p = .003$ for the 5-year-old class). These children were significantly more likely to choose the correct responses than expected by chance in both tasks ($p < .001$ for all six two-tailed binomial tests).

Discussion

The present study extended work on emergent literacy to learners of a language and writing system that has rarely featured in this research, Chinese. We studied Chinese children in order to test the hypothesis (Bialystok & Martin, 2003; Tolchinsky Landsmann & Karmiloff-Smith, 1992) that children begin to learn about the outer form of writing from an early age, earlier than they learn about how its units symbolize units of language. Chinese provides a good test of this hypothesis because its units symbolize syllables, not phonemes as in alphabetic writing systems.

Chinese 3- to 5-year-olds discriminated between Chinese and Kannada symbols in the graphic task, accepting Chinese symbols as writing above the level expected by chance. Our written stimuli were characters that were low in frequency and that consisted of relatively rare components, ruling out the possibility that children used knowledge about specific characters or components to guide their decisions. We therefore provide evidence, stronger than that presented by Qian *et al.* (2015), that Chinese children as young as 3 years know about some general graphic characteristics of their writing system. Such graphic knowledge appears to emerge in learners of Chinese at similar ages as in learners of alphabetic writing systems (Lavine, 1977; Treiman *et al.*, 2007). It is likely that young children learn implicitly about the graphic characteristics of writing through exposure to print around them rather than through explicit teaching.

When asked in the phonological task how to write a familiar one-syllable or two-syllable spoken word, 3- to 5-year-old participants tended to choose the display with as many characters as syllables in the spoken word. These children's above-chance performance suggests that an implicit understanding of the correspondence between characters and syllables develops earlier than suggested by previous research in which Chinese children were asked to produce characters (Chan & Louie, 1992). Such early knowledge is consistent with the finding that Chinese 3-year-olds can detect syllables in speech (Shu *et al.*, 2008). As reviewed earlier, an understanding of the correspondence between units of writing and units of speech does not typically emerge as early in learners of alphabetic systems (e.g., Bialystok, 1991; Pollo *et al.*, 2009; Rozin *et al.*, 1974). The different results for Chinese and Western children may reflect the different ways in which units of writing map onto units of speech in Chinese and alphabetic writing systems.

The finding that 3- to 5-year-olds produced more correct responses in the graphic task than the phonological task supports the hypothesis (Bialystok & Martin, 2003; Tolchinsky Landsmann & Karmiloff-Smith, 1992) that it is easier for children to learn about what writing looks like than to learn about how units of writing map onto linguistic units. Importantly, our results suggest that this holds true even when the linguistic units to which writing maps are relatively accessible. This priority for outer form over inner structure is consistent with the idea that patterns within the visual modality are easier to learn than patterns that co-occur across two modalities (Treiman & Kessler, 2014). An alternative possibility is that children's poorer performance on the phonological task reflects the greater cognitive demands of this task, in particular its greater demands on working memory. Future studies are needed to test this idea.

Our 2-year-old participants did not respond above the level expected by chance in either the graphic or phonological task, perhaps because of a lack of knowledge about both the outer form and inner structure of writing or perhaps because both tasks were cognitively demanding for children of this age. Studies using other methods (e.g., Treiman & Yin, 2011) point to some knowledge about the outer form of writing in 2-year-olds, however, and additional work is needed with this age group. More research is also needed to tease apart the influences of morphological and phonological information in linking units of writing and units of language. Our stimuli were representative of the majority of Chinese words in that most had the same number of syllables as morphemes. A child who believes that there should be as many meaning units as characters could have responded correctly. This strategy would not have worked for some other items in our study, including the two-syllable monomorphemic word /$p^hu˩$ t^hau/ 'grapes'. Future studies using more two-syllable monomorphemic stimuli would be needed to disentangle the influences of morphological and phonological information. Another topic that requires further study is Chinese children's knowledge of graphic properties of writing that are

more subtle than those investigated here. For example, some radicals occur in a fixed position within a character, and learners of Chinese appear to be sensitive to these positional regularities at about 6 years of age (e.g., Chan & Nunes, 1998; Qian *et al.*, 2015; Tong, McBride-Chang, Shu, & Wong, 2009; Yin & McBride, 2015).

Although additional research is needed, the present investigation adds to our knowledge about how children learn about the symbol systems of their society. In particular, the findings support the hypothesis (Tolchinsky Landsmann & Karmiloff-Smith, 1992) that learning about the outer form of a notation system is developmentally precocious.

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Appendix: Stimuli used in the graphic and phonological tasks

Graphic task			Phonological task		
Chinese display	Kannada display	Spoken word (translation)	Two-character display	One-character display	Spoken word (translation)
柬	ಔ	/tʰiɑuꓦ/ (‘to jump’)	酉乍	酉	/tʂuꓶ/ (‘pig’)
壬	ಅ	/tʂuꓶ/ (‘pig’)	秉皿	秉	/tʰɑŋˊ/ (‘candy’)
疋	ರ	/tʰɑŋˊ/ (‘candy’)	匀毛	匀	/pʰĄˊ/ (‘to crawl’)
夆	ಣ	/pʰĄˊ/ (‘to crawl’)	吏聿	吏	/tʰiɑuꓦ/ (‘to jump’)
戋	ಪ	/kuaiꓶ/ (‘well-behaved’)	幺囱	幺	/kʰuꓶ/ (‘to cry’)
囱	ಟ	/kʰuꓶ/ (‘to cry’)	夆廾	夆	/kuaiꓶ/ (‘well-behaved’)
陪	ಖ	/pʰɑuꓵˊ/ (‘to run’)	爻臾	爻	/liænꓵˊ/ (‘face’)
彭	ಘ	/liænꓵˊ/ (‘face’)	曳夭	曳	/pʰɑuꓵˊ/ (‘to run’)
臾殆	ಥಈ	/miꓦ fəŋꓶ/ (‘honeybee’)	矢豕	矢	/suŋꓶ ʂʰu ꓵˊ/ (‘squirrel’)
酉矢	ಖತ	/ɕyŋˊ mɑuꓶ/ (‘panda’)	戊禹	戊	/ʂʰĄꓶ fĄꓶ/ (‘sofa’)
夭走	ಐಸ	/luoꓦ tʰuoˊ/ (‘camel’)	彖丐	彖	/ʂʰueiꓦ tɕiɑuꓦ/ (‘to sleep’)
幺柬	ಔಸಿ	/suŋꓶ ʂʰu ꓵˊ/ (‘squirrel’)	壬臼	壬	/miꓦ fəŋꓶ/ (‘honeybee’)