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Writing Quality in Chinese Children: Speed and Fluency Matter

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Abstract

There were two goals of the present study. The first was to create a scoring scheme by which 9-year-old Chinese children's writing compositions could be rated to form a total score for writing quality. The second was to examine cognitive correlates of writing quality at age 9 from measures administered at ages 6–9. Age 9 writing compositions were scored using a 7-element rubric; following confirmatory factor analyses, 5 of these elements were retained to represent overall writing quality for subsequent analyses. Measures of vocabulary knowledge, Chinese word dictation, phonological awareness, speed of processing, speeded naming, and handwriting fluency at ages 6–9 were all significantly associated with the obtained overall writing quality measure even when the statistical effect of age was removed. With vocabulary knowledge, dictation skill, age, gender, and phonological awareness included in a regression equation, 35% of the variance in age 9 writing quality was explained. With the variables of speed of processing, speeded naming, and handwriting fluency additionally included as a block, 12% additional variance in the equation was explained. In addition to gender, overall unique correlates of writing quality were dictation, speed of processing, and handwriting fluency, underscoring the importance of both general automaticity and specific writing fluency for writing quality development in children.

Keywords

Dictation; Phonological awareness; Longitudinal study; Writing quality

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The focus of the present study was twofold. First, we sought to develop a scoring method to evaluate young Chinese children's writing compositions. This was a goal given a paucity of research on writing compositions from Chinese children thus far, making it important to consider the elements of writing composition that are critical to include in estimating an overall writing quality score in samples from children writing in Chinese. Second, we examined correlates of children's text writing quality at age 9 based on our scoring from earlier cognitive measures obtained for these children at ages 6, 7, and 8, in order to understand what the precursors to quality writing might be. Below, we first review basic concepts about writing composition in children and then consider what might be the developmental precursors to and correlates of good composition skills.

Hayes (1996) and Hayes and Flower (1980) identified three underlying processes of planning, translating, and reviewing as core aspects of writing. Berninger and Swanson

(1994) further identified two separate components of translation which are essential for developing writers, namely text generation and transcription. Text generation refers to finding the language to represent one's ideas, whereas transcription refers to representing the language as written symbols. This aspect of transcription consists of the skills of handwriting and spelling (Berninger et al., 2002). Transcription might seem mechanical for skilled writers who have automatized such processes, but it is a labor-intensive task that is quite effortful for young writers (Berninger, 1999). In contrast to skilled writers, developing writers engage in little explicit planning and revision (Bereiter & Scardamalia, 1987).

Different researchers have established different systems for evaluating writing in children. For example, Cameron et al. (1995) focused on both total word count and overall writing cohesion in their analyses of children's narrative compositions. The element of cohesion in that study of 9-year-olds focused on conjunctions, referential markers, and lexical cohesion, all in relation to T-units. A T-unit was defined there, as elsewhere (e.g., Wagner et al., 2011), as one "independent clause, with all subordinate elements (phrases, clauses) attached to it" (p. 262).

In the present study, we made reference to both the approaches of Wagner et al. (2011) and those of Nelson, Bahr, and Van Meter (2004) to develop seven categories of evaluation for the essays we analyzed. One novel aspect of the present study was an explicit focus on Chinese writing composition. Although there are likely many universals to writing composition across scripts, there are also some differences. Wagner et al. (2011) divided their coding into four broad areas of macro-organization, (syntactic) complexity, productivity, and mechanical errors.

However, because grammar and syntax are sometimes more ambiguous and difficult to categorize in Chinese as compared to English, syntactic complexity was not a focus of the present study. Indeed, the concept of the T-unit, used in previous work on English writing (Cameron et al., 1995; Wagner et al., 2011) was not incorporated because of ambiguities in grammar and syntax in these essays. In addition, Chinese punctuation tends to be quite free-flowing and more ambiguous than English with regard to positioning of commas and periods. Moreover, the Chinese script does not make use of uppercase and lowercase graphemes, so the concept of capitalization as a category of mechanical error does not make sense. Indeed, mechanical error variability was even relatively minimal as compared to the other dimensions identified by Wagner et al. (2011) in English-speaking children; thus, it was not included in the present study.

Instead, our own ratings of writing compositions in the present study focused on content, and organization only. We conceptualized content as being comprised of relevance, depth, and breadth, as shown in Table 1. All of these basically captured the extent to which children stayed on topic in their writing. Organization was measured in four aspects—within sentence organization, overall paragraph organization, presence of summarization sentences as introductory and conclusion sentences, and a more subjective intelligibility rating for the entire essay. Productivity was a measure separate from the quality ratings, made up only of the total number of Chinese characters comprising the essay. These elements were identified and scored by the first author, an experienced language teacher, and double-coded by a second coder. One focus of our analyses was the extent to which these elements would be intercorrelated. We sought to retain as many of these elements as possible in a total score of overall writing quality. We then examined correlates of this overall writing quality dimension from children's previously measured cognitive skills. The cognitive variables included in these analyses were measures of automaticity/fluency, phonological awareness, dictation, and vocabulary knowledge. Our rationale for the inclusion of these variables is detailed below, in relation specifically to the demands of writing composition, an incredibly complex phenomenon.

Indeed, the complex task of writing in children involves an interplay of cognitive processes. For example, some disparate tasks for writers include meeting their goals for content and grammaticality, as well as retrieving words and organizing these words into meaningful language and text (McCutchen, 1996). In older children, tasks such as planning, drafting, reviewing, and revising might be sequenced, so that children could undertake one task at a time to reduce the competing cognitive demands of each (e.g., Christensen, 2005). However, writing processes are recursive (Berninger & Swanson, 1994; Hayes & Flower, 1980), so the problem of cognitive demand is often particularly apparent for developing writers, who may feel overwhelmed by all the diverse requirements of writing. One approach to dealing with this problem of limited cognitive capacity during the writing process is to develop automaticity in lower-level processes such as spelling or fluency of handwriting (e.g., McCutchen, 2006; Medwell & Wray, 2007), so that cognitive resources can be freed up for higher-level processes, such as ideas generation and monitoring of goals. Automaticity is achieved when a given process can be carried out accurately, swiftly, and without a need for conscious attention (LaBerge & Samuels, 1974). In addition to automaticity, which is domain specific, general speed of processing is important for general cognitive capacities (e.g., Horn & Cattell, 1966; Kail, 2000), including literacy skills (e.g., McBride-Chang & Kail, 2002).

Specific examples of the importance of automaticity for writing in children come from a variety of research studies. The degree of transcription automaticity is important to the quality of children's compositions. For example, composition quality tends to improve significantly when the text is dictated to an adult orally, rather than written on paper (see Hidi & Hilyard, 1984; McCutchen, 1988, 1996; Scardamalia, Bereiter, & Goleman, 1982). Such studies suggest that the effortful process of writing itself substantially slows down the process of writing composition in children. Thus, one particularly salient aspect of transcription for young children is handwriting. Over the past decades, studies have been carried out to investigate the role handwriting plays in writing in English-speaking children (e.g., Berninger & Graham, 1998; Jones & Christensen, 1999; Wagner et al., 2011) and even college students (e.g., Connelly, Campbell, MacLean, & Barnes, 2006). For example, Wagner et al. (2011) recently demonstrated that handwriting fluency was one of the five underlying dimensions of written compositions in first and fourth grade English-speaking students. Despite previous work on handwriting in relation to writing composition in English-speaking children, however, no known research has investigated the importance of handwriting fluency for Chinese children's writing. Particularly, given previous claims that writing may be a special aspect of Chinese literacy development because of the intense cognitive demands of Chinese writing, especially the ordering of strokes in each Chinese character (e.g., Tan, Spinks, Eden, Perfetti, & Siok, 2005), handwriting fluency may be an important element to consider for understanding Chinese children's writing compositions.

The link between handwriting fluency and composition (e.g., Graham et al., 1997; Jones & Christensen, 1999) may be partly via the skills of orthographic knowledge and finger functioning, which are significantly associated with composition writing quality and quantity (Berninger et al., 1992). Handwriting fluency develops over childhood (Scardamalia et al., 1982). Indeed, Berninger and Graham (1998) showed that handwriting continues to demand cognitive attention even for those in secondary school and beyond. Thus, handwriting fluency instruction tends to improve overall compositional fluency, including both amount written (Berninger et al., 1997; Jones & Christensen, 1999), and writing quality (Jones & Christensen, 1999).

Apart from handwriting fluency, we also wondered about speed of processing more generally, given previous research demonstrating that general speed of processing has a strong link to other reading-related skills (e.g., McBride-Chang & Kail, 2002). Writing and reading share many analogous cognitive processes (Shanahan, 1984), including the importance of automatization for both. Whereas general speed of processing taps general cognitive capacity (e.g., Kail, 2000), rapid automatized naming (RAN) is a measure that is often linked to literacy skills specifically. RAN has been a unique cognitive correlate of both Chinese word/character reading (e.g., Chow, McBride-Chang, & Burgess, 2005; Ding, Richman, Yang, & Guo, 2010; Li, Shu, McBride-Chang, Liu, & Peng, in press; Liao, Georgiou, & Parrila, 2008; Shu, McBride-Chang, Wu, & Liu, 2006) and writing (e.g., Chan, Ho, Tsang, Lee, & Chung, 2006; Ding et al., 2010). Like general speed of processing tasks (e.g., Kail & Salthouse, 1994), RAN becomes faster with age. Thus, we included both general speed of processing and RAN as possible predictors of subsequent writing composition quality in the present study.

Phonological awareness was another variable included in the present study. Phonological memory is centrally implicated in writing composition skills (e.g., Levy & Marek, 1999), because children must continuously think about and recall the points they are trying to make within the composition. At a lower level, phonological analysis itself is also necessary in order to relate Chinese character sounds to their orthographic structures in character recognition (e.g., Ho & Bryant, 1997; Leong, Cheng, & Lam, 2000). For example, phonological awareness has been linked to dictation skills in Chinese in several studies (e.g., Chan et al., 2006; Tong, McBride-Chang, Shu, & Wong, 2009; Tong et al., 2010). Moreover, phonological memory and phonological awareness tend to be moderately associated in Chinese children (McBride-Chang & Ho, 2000), and phonological memory itself is an important correlate of writing composition as well. Admittedly, phonological awareness is likely an ability that is relatively indirectly associated with writing composition because of its more primary role in dictation skill development. Its consistent inclusion in the early years of this longitudinal study allowed us to test its effects in the present study beyond, and sometimes in place of, the importance of dictation, that is, spelling.

One of the strongest correlates of writing composition in children thus far has been spelling (e.g., Graham et al., 1997; McCutchen, 1996). During the translation process of composition writing, one's ideas must be transcribed to form a written representation of text (Berninger & Swanson, 1994); spelling is a primary component of transcription (Berninger et al., 2002). Once spelling becomes automatic, children are able to retrieve spellings directly from long-term memory, rather than continuously constructing them from phonological, orthographic, and/or morphological information (Gentry, 1982). Good spellers maximize fast and accurate strategies and minimize use of slower strategies, thus showing an overall efficiency that is lacking in poorer spellers (Rittle-Johnson & Siegler, 1999). Direct retrieval of spellings clearly minimizes use of cognitive resources in the writing process (McCutchen, 1996). Conversely, it is possible that some children might abandon some ideas, thus producing a shorter or rougher written composition, simply because of lack of knowledge about the spellings of certain words. For this reason, it should also be noted that making fewer spelling mistakes in compositions does not necessarily reflect a higher spelling ability per se; spelling might be constrained at different levels of processing during writing composition. Since the ability to spell cannot be fairly compared in the self-generated compositions, standard dictation tasks were administered to measure children's ability to spell Chinese characters in this study. We note that the term spelling has traditionally been used to describe the process by which individuals represent words using letters of a given alphabet. Because Chinese is represented using characters, there is no English word that precisely captures the process of printing Chinese words. Thus, following Tong et al. (2009), we use the terms spelling and dictation interchangeably in the present study in order to reflect the fact that in both spelling and dictation processes across orthographies, the primary focus is on writing a word from memory using various cues and typically checking the final written product to determine whether it looks correct.

A final variable included longitudinally in the present study was vocabulary knowledge. The translating element of models of writing (Berninger & Swanson, 1994; Hayes, 1996; Hayes & Flower, 1980) centers particularly on text generation. Vocabulary knowledge seems essential to this aspect of writing. Without strong vocabulary knowledge, it is more difficult to create rich compositions. This is partly why Wagner et al. (2011) examined lexical diversity as well as overall word length in their study of children's compositions. Greater lexical diversity correlates with more advanced writing, affecting both length and content (Beard, 1986) of children's compositions. Moreover, vocabulary diversity appears to be stably associated with writing quality across different writing tasks (Olinghouse & Leaird, 2009).

In the present study, we tapped children's overall word knowledge. We reasoned that students with better vocabulary knowledge potentially have a greater diversity of vocabulary knowledge; this knowledge is likely also more readily available for retrieval. Because of their ability to explain word meanings more fully, children with good vocabulary knowledge may also potentially be better prepared to retrieve the right words in context. In this way, their streams of thought and fluency of expression are unhindered in the process of translation. Following this logic, fewer cognitive resources in children with adequate vocabulary knowledge would be taken up when searching for the right word in the process of writing. This might thus benefit writing quality on the whole. We tested this idea in the present study.

To summarize, the present study focused on (a) coherence of scoring of Chinese children's writing compositions and (b) longitudinal correlates of these compositions. These correlates were automaticity/fluency (including concurrent handwriting fluency), speed of processing, phonological awareness, dictation, and vocabulary knowledge. Because of previous work suggesting that automaticity is so strongly linked to writing composition quality (e.g., Connelly et al., 2006; Wagner et al., 2011), we were particularly interested in isolating the unique contributions of speed- and fluency-related variables to writing composition. We also sought to determine which of the individual correlates of writing were uniquely associated with writing composition when all were included simultaneously.

METHOD

Participants

Participants were native Cantonese-speaking children who were originally recruited from five Maternal and Child Health Centers located in four regions (Kowloon, Hong Kong, New Territories East, and New Territories West) across Hong Kong. The database for this study was originally compiled as part of a larger longitudinal project which was at its eighth year in 2009. Data for this study were collected yearly from 2006 to 2009. In May to July 2006, 197 children aged 66–80 months (M = 73.39, SD = 3.47) were sampled. Thus, the children were around 6 years old at that time. In September 2007 to January 2008, the 175 remaining children were around 7 years of age, that is, from 80 to 97 months old (M = 88.31, SD = 3.89). In June to September 2008, 166 children remained, ranging in age from 89 to 104 months old (M = 97.07, SD = 3.44). The 153 (62 boys, 91 girls) children included in the present study were those who wrote compositions from July to September 2009, when they were approximately age nine, that is, from 103 to 117 months old (M = 109.64, SD = 3.43). Variables in this study were labeled as age 6, 7, 8 and 9 according to the year data were collected.

From 2006 to 2009, 44 participants dropped out of the study. Given this attrition, we conducted analyses to see if those who remained (154 children) in the study across the 4 years were systematically different from those lost during the testing years (44 children). Two groups were compared on demographic information, including age, mother's education level, gender and non-verbal IQ. We found a group difference for gender, $t(195) = -2.20$, $p < .05$, with the drop-out group having slightly fewer boys than girls (boys: 41%). However, the two groups were similar on mother's education level, $t(195) = -.298$, $p = .76$, age, $t(195) = -.696$, $p = .49$, and non-verbal IQ as measured by Raven's Progressive Matrices (at age 4), $t(195) = -.041$, $p = .97$.

Procedures

Consent forms were obtained from participants' parents. A convenient testing time was individually arranged with the participating children and their caregivers in the summer months. All tasks were administered by trained psychology students in a session that lasted approximately 1–1.5 h in the children's home, for each year of testing. Participants were from all over Hong Kong, because they were originally selected to be statistically representative of all of Hong Kong. From year to year, different tasks were administered in the longitudinal study based on both theoretical interests and practical issues. Thus, the years in which each of these measures was administered is given under the description of each task below.

Measures

Chinese composition—The way in which written samples were obtained followed the instructions from Wagner et al. (2011), adapted for individual children at home. Children were expected to write continuously within the time limit for this task, administered only at age 9. Examiners introduced the writing task by saying (in Cantonese):

> Please use Chinese to write a composition entitled ‘My Favorite Toy’. When you are writing, I want you to stay focused and keep writing the whole time. Don’t stop until I tell you to. Also, if you get to a word that you don’t know how to write, you don’t need to ask people how to write it. Simply use a homophone or similar words to replace it for now. If you make a mistake, cross out the word and keep writing. Don’t erase your mistake because it will take too long. Do you understand?

After answering children’s queries, children were further instructed:

> Remember, the topic is ‘My Favorite Toy’. Think about whether you had or have a favorite toy, or which toy you really want to own. Can you describe it? Why do you like it? If you are clear about the topic, you can start writing.

Children had 10 min to write. If they stopped writing before the 10 min were up, examiners encouraged them to continue by saying:

> Are there any other things about this toy you can describe?

The written samples were then coded by two raters according to the seven variables described below. Total number of characters written as a measure of productivity and total number of words (by character) that were incorrectly written as a measure of spelling errors were also counted.

Written samples coding

Analysis of written samples—In order to reflect and record children’s compositions as objectively as possible, the first author, who was a secondary school language teacher, developed a 7-element rubric for evaluating children’s Chinese written samples (see Table 1) on the basis of content and organization. The maximum score for each element was four, for a maximum possible total of 28 as an overall score for the writing quality construct. Each rating category is detailed below.

Content: We noticed in the writing samples that richness of content could not be fully represented using only a single dimension. Some children elaborated in great detail on one particular aspect of the topic, whereas some provided shallow content but touched on a variety of aspects. Therefore, our scheme covered both breadth and depth of content. Breadth represents the full coverage of dimensions of this topic, and depth shows how well-elaborated the ideas covered are. Relevance was coded to represent whether the composition content was related to the topic. Regardless of how rich the content was, we penalized irrelevant pieces using this dimension in the representation of content.

Organization: Because intra-individual differences are often found to exist in translation separately at the word, sentence, and text levels (e.g., Berninger & Swanson, 1994), we rated organization at both the sentence and paragraph levels. Organization at the sentence-level focused on the presentation of unit ideas in a smooth way to form complete sentences. Organization at the paragraph-level represents the logical ordering and grouping of relevant ideas within paragraphs.

The element of prominence of organizational key elements measures the presence of topic markers, such as the topic sentence and conclusion. A similar element of key elements was also included by Wagner et al. (2011). Teachers in Hong Kong often focus their students on these elements in reading comprehension exercises, and they encourage students to use such strategies to organize their own writings.

The element of intelligibility summarizes the extent to which the written sample is easy to understand despite any problems in organization or language mechanics. Since different factors impede understanding of different readers, this is a more subjective component in the rubric. It was necessary to include this more-holistic element so as to capture other factors which are not emphasized in the rubric, such as language mechanics, including word order and sequences of idea presentation.

Coding procedure

A preliminary rubric of the seven elements was drafted based on an initial impression of children's composing ability. After experimenting with the preliminary rubric using 30 written samples, the rubric descriptors were refined so that the scores could better distinguish abilities of Hong Kong children in this age range (see Table 1).

Anchor samples were identified for each score, and a research assistant with an undergraduate degree in psychology was trained as the second rater to evaluate the written samples with reference to the rubric and anchor papers. After the second rater practiced with the same 30 samples, consensus was reached through discussions regarding differences in subjective judgments in special cases. A list of guidelines specific to this written task was also created (see Table 2).

The two raters then rated the remaining 124 samples and recoded the first 30 papers following the refined rubric and guidelines. Inter-rater reliabilities of the seven elements based on the whole sample of 154 children are represented as Pearson's correlation coefficients ranging from .72 to .81 as shown in Table 3. The average score across both raters was used as the final score.

Processing speed

Two subtests from the Woodcock-Johnson Tests of Cognitive Ability (Woodcock & Johnson, 1989) were administered to assess the speed of processing. For both tasks, the maximum time allowed was 180 s. The total number of rows with correct marking became the scores reported. The raw scores were then normalized and standardized based on an American sample (*M* = 100, *SD* = 15). Although this was not ideal given that these tasks had not been normed on Hong Kong Chinese children, this way of scoring was useful in that it made use of accuracy and speed data simultaneously. In addition, because all of these data were used for correlations but not direct group comparisons, the rank ordering of faster and slower children remained the same using this method. These tasks were administered only at ages 6 and 7.

Visual matching—In the Visual Matching task, children were shown sixty rows of 6 numbers each. They were required to identify and circle identical numbers in the same row.

Cross out—In the Cross Out task, children were presented with 30 rows of 20 figures each. They were asked to identify and cross out five figures that are identical to the target figure.

Speeded naming

For this task, five rows of five single-digit numbers were presented in a random order across columns on a piece of paper. Children were instructed to name each of these 25 numbers using Cantonese as quickly as possible row-by-row, beginning with the first number in the first row. The time taken to read these 25 numbers was recorded using a stopwatch. Children were given this naming task twice. The average time taken across the two trials was the score reported. Data on this task were obtained for the children at ages 6, 7, and 8.

Handwriting fluency

The handwriting fluency tasks were an extension from Wagner et al. (2011), adapted into Chinese. These tasks were a Chinese number copying task and a Chinese sentence copying task. The tasks were introduced as games to find out how quickly the children could write. Both were administered only at age 9. For the Chinese number copying task, children were asked to write the Chinese numbers 1–10 (e.g., 一, 二, 三, 四) quickly within 1 min. They were instructed to start writing from 1 again after they had finished writing 1–10. After 1 min, participants were asked to stop and put their pens down. The score reported is the total number of Chinese numbers correctly written.

As for the Chinese sentence copying task, participants were first asked to read aloud a simple Chinese sentence "媽媽永遠是和藹可親的" printed on an instruction sheet. Before they began, children were told they had to copy the sentence as quickly as they could, as many times as they could, within 1 min. They were also told the more they could write, the better it was. Participants were then given 1 min for the task. The score for this task was the number of characters correctly copied.

For these two writing fluency measures, a student helper first coded the answers for all the participants, and then one of the authors randomly picked 30% papers (46 subjects) and recoded them again to yield inter-rater reliabilities for each as shown in Table 6.

Phonological awareness

The construct of phonological awareness was measured with a combination of syllable deletion and syllable onset deletion items at ages 6, 7, and 8 only. Children received one point for each correctly answered item in the task. Syllable items were comprised of three-syllable words from which a single item was deleted. All items were administered orally. For example, with the initial syllable /fo2/ (fire) deleted, "火車站" /fo2 tse1 dzam6/ (train station) would become "車站" /tse1 dzam6/ (station). Syllable onset items consisted of real and pseudowords. Children were asked to repeat given syllables without the initial sound. For example, "快" /faai3/ (quick) would become "嗌" /aai3/ (shout) without the consonant. This task has been described elsewhere (e.g., Tong et al., 2009).

Chinese word dictation

This task, administered at ages 6, 7, and 8 only, was adapted from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (Ho, Chan, Tsang, & Lee, 2000). Children were asked to write 20, 25, and 48 two-character words for the test at ages 6, 7, and 8 years old respectively. Testers read aloud every word one by one, and children were then asked to write one character in each square provided and to put a cross in the square when they came across a character they did not know how to write. The test was stopped once the children wrote eight consecutive words incorrectly. Each correctly written character was allotted one point.

Vocabulary definitions

This task, designed to measure children's vocabulary knowledge, was administered across all ages 6–9. All words chosen for this task appear frequently in textbooks of Hong Kong primary schools (Zhuang, 2000). Procedures and scoring scheme from the Hong Kong Wechsler Intelligence Scale for children (Hong Kong Education Department & the Hong Kong Psychological Society, 1981) were adopted for this task. Children were required to provide explanations for 52 vocabulary items which were arranged in increasing order of conceptual difficulty. With reference to a Chinese dictionary (Lau, 1999), a detailed scoring key with examples was created. Children were awarded zero, one, or two points for each word orally identified by the experimenter and defined by the child. Two points were given for a clear description or a synonym and one point was given for an ambiguous answer or an example to describe the target word. Zero points was given for a wrong description or a mere repetition of the target word. If the children scored zero across five consecutive items, the testing was stopped.

RESULTS

The writing scores were found to be fairly normally distributed in general, except for the negatively-skewed relevance (skewness = −1.07) and the positively skewed key elements (skewness = 1.06). Half (50.33%) of the 9-year-old children sampled produced totally relevant compositions, and more than half (52.32%) of them included either an easily identifiable topic sentence or conclusion. As shown in Table 4, apart from relevance, all dimensions were found to be significantly correlated with one another. Intelligibility in particular had moderately high associations with depth (r = .71), sentence organization (r = .

76) and, paragraph organization (*r* = .77). Paragraph organization also had a moderately high association with depth of content (*r* = .74).

In order to get a holistic picture of each child's writing quality for the purpose of correlating other cognitive skills with it, we tested whether a single index could be extracted from the 7 elements initially defined by fitting a confirmatory factor analytic model with a single factor and the 7 elements as indicators. This model provided a poor fit to the data, $\chi^2(14, N = 153) = 76.3$, $p < .00001$, CFI = .89, TLI = .83, RMSEA = .17. We tested several two- and three-factor models, none of which proved satisfactory in that correlations between the factors equaled 1. Further examination of the initial single-factor model suggested that two of the seven indicators were not performing as expected. We first dropped relevance as an indicator and tested a single-factor model with the 6 remaining elements included. The goodness of fit was largely improved in this model but still did not adequately fit the data, $\chi^2(9, N = 153) = 33.7$, $p < .001$, CFI = .95, TLI = .92, RMSEA = .13. Finally a single-factor model with breadth further dropped was the only adequately fitting model, $\chi^2(5, N = 153) = 10.8$, $p = 0.06$, CFI = .99, TLI = .97, RMSEA = .09. That is, the final model included only the following five elements: depth, sentence organization, paragraph organization, key elements, and overall intelligibility. Because these five variables loaded on one single factor, the sum of these was used as the index of overall writing score for further analyses. Table 5 shows the correlations among all of these retained writing element variables and overall writing quality.

Table 6 then shows the number of cases, means, standard deviations, minimum and maximum values, and reliabilities for all the measures collected from the 153 children when they were 6, 7, 8, and 9 years old, respectively. Some missing data were noted in a few tasks. Adequate variability, as indicated based on the ranges and standard deviations of the measures was obtained across all of these measures, except for number of characters incorrectly written. Children in general made few spelling (i.e., writing) mistakes ($M = 1.17$). Most (84.11%) of them wrote two or fewer characters incorrectly in the writing task. Only one student made an exceptionally large number of dictation mistakes, with 12 incorrectly written characters out of a total of 27 characters.

From the zero-order correlations of all measures with age 9 overall writing quality as shown in Table 6, one can see that all variables included in the present study correlated significantly with overall writing quality. Across the years, dictation tasks were moderately associated with age 9 overall writing quality. There was also a relatively high correlation ($r = .74$) between length of composition, our productivity variable, and overall writing quality.

We tested for gender effects as well. Interestingly, these analyses showed that girls wrote significantly longer compositions than boys, $t(149) = -4.26$, $p < .01$. Girls' compositions were also judged to be of higher quality than boys, $t(149) = -.4.06$, $p < .001$. Perhaps correspondingly, girls also consistently performed better in the dictation task than did boys at age of 6, $t(133.61) = -2.36$, $p < .05$; age 7, $t(124.18) = -3.45$, $p < .01$; and age 8, $t(117.99) = -2.94$, $p < .01$.

The first-order correlations of all the measures with age statistically controlled are shown in Table 7. Tasks representing the same construct overtime tended to be moderately associated with one another. There was some association between the number of characters incorrectly written in the composition at age 9 and children's dictation scores at ages 7 ($r = .23$, $p < .01$) and 8 ($r = .25$, $p < .01$).

One main area of interest in our regression analyses was to test the extent to which the automatization and speed variables as a whole improved the variance explained in writing composition quality, beyond the control variables of age, phonological awareness, dictation, and vocabulary knowledge. We, therefore, carried out a hierarchical regression analysis in two steps. At step one, the control variables were all included. At step two, the automatization and speed variables were then entered as a block, as shown in Table 8. The individual variables included were based on raw correlations. We included one measure of each variable, and we selected the variable at the age when this association was highest, because we wanted to avoid multicollinearity problems likely to arise from the inclusion of the same variable over several years given relatively strong associations across years. The control variables significantly predicted a total of 35% of the variance in writing quality in Block 1. The automaticity and speed variables as a group then explained a statistically significant 12% additional variance in overall writing quality beyond these control variables. Table 9 shows the final beta weights of all variables included in this equation. Age 8 dictation, age 6 Cross Out, and age 9 handwriting fluency (for sentences) were unique correlates of overall writing quality in this regression equation, as was the control variable of gender.

DISCUSSION

There were two primary goals of the present study. The first was to create a scoring system for age 9 Chinese children's writing compositions. The second was to look at cognitive correlates of these writing compositions from ages 6–9. In particular, we tested whether speed and automaticity would contribute unique variance to writing compositions beyond skills in phonological awareness, dictation, and vocabulary knowledge. We indeed successfully developed a scoring system for these compositions using five different dimensions and then collapsed these dimensions to form an overall score of writing in the present study. Using this overall writing quality score, we then demonstrated that speeded variables together contributed a unique 12% of the variance in writing composition quality in the present study. Moreover, across all measures, one test of general speed, Cross Out, at age 6, as well as handwriting fluency at age 9 were unique correlates of writing. Dictation at age 8 also emerged as a strong unique correlate of writing composition, as found in previous work (Graham et al., 1997; McCutchen, 1996).

The overall writing quality measure consisted of five of the original seven elements scored. The two elements that were ultimately dropped following factor analyses both related to what we conceptualized as aspects of content, that is, relevance and breadth. Most of the children showed little variability in the dimension of relevance. Rather, almost all children focused on the topic as requested. Our Table 2 highlights some special difficulties encountered during our scoring of these writing compositions, and all were related in some way to content. Thus, breadth also was difficult to incorporate into the single quality element as noted. Still, the depth aspect of what we considered to be content was retained in this analysis, as were all four other elements originally identified.

Apart from our focus on Chinese, what is unique about the present study is that we examined longitudinal correlates of this writing quality dimension as defined. Our data set was unique in allowing this opportunity because of the variables we had collected across years prior to this composition task. Importantly, because participants in the present study came from all over Hong Kong, the effects of teaching on writing quality may have been relatively well controlled in the present study.

Overall, with age and other cognitive skills statistically controlled, our block of speed and fluency measures was strongly predictive of overall writing quality. This finding suggests that basic automaticity frees up cognitive resources, thus making more cognitive space available for higher-level compositional processes such as depth of ideas, organization, and intelligibility (Berninger et al., 1992; McCutchen, 1988, 1995, 1996), and that general speed of processing also contributes to performance. One practical implication of these findings is that a focus on automaticity may be particularly helpful for fostering writing skills. Transcription itself can be over-trained to achieve automaticity (Fayol, 1998). These results underscore the potential importance of training of automaticity when possible.

Our findings on writing composition in boys and girls demonstrated that girls wrote more and scored higher on overall writing quality. This is not surprising given the rather high association of .68 between number of characters produced and overall writing quality. Berninger and Fuller (1992) found similar patterns in their sample of American children. In the present study, girls also significantly outperformed boys across years in the task of dictation. Importantly, dictation was a unique correlate of writing composition as well in the present study. Thus, it remains unclear whether the gender difference in writing composition for this group was attributable primarily to lower-level writing skills or to higher-order planning writing skills or a combination. Given that gender was a unique correlate of writing quality in the final regression equation, it seems clear that this variable is important to consider in future work on writing quality for this age group, however.

There were several limitations of the present study. First, we used the same data to establish a coding system for writing composition and to correlate this measure of writing composition with other cognitive measures. It would have been better to have developed this coding system on a separate sample from the longitudinal one included in the study. At the same time, however, this data set represented a unique opportunity to examine cognitive correlates of writing in young Chinese children. Future work might try to make use of this coding scheme in an attempt to further validate it.

In addition, this study included measures of writing composition and writing fluency only in the final year of sampling. Thus, the direction of association between handwriting and writing composition cannot be established given these data. Most researchers tend to argue that handwriting fluency forms the foundation for writing composition (e.g., Wagner et al., 2011). However, without longitudinal studies examining both handwriting fluency and writing composition, as well as training studies aimed at promoting handwriting fluency in order to facilitate better quality writing composition, the direction of this association cannot be established. It would also be desirable to look at the developmental changes in writing composition itself over time, a goal of future work measuring writing composition skills across time.

Another issue in the present study is the relative importance of fluency in writing composition. Although it is clear that fluency and speed were unique correlates of writing composition, it is difficult to gauge their relative importance from these findings. For one thing, our task of writing composition was itself a timed measure. Many other studies in this area make use of similar timed measures. A longer time limit in future studies could be helpful in understanding the relative importance of fluency. Nevertheless, it is essential to acknowledge that the findings of the present study were limited by the way in which we tapped writing fluency and the specific variables included in the present study to explain the overall writing composition measure.

Finally and on a related point, there are additional cognitive correlates of writing that would have been useful to have included in the present study. For example, memory skills, fluency of idea generation, topic knowledge, and discourse knowledge might all be useful to examine in future research on children's writing composition development (e.g., Hayes & Flower, 1980; Means & Voss, 1985; Olinghouse & Graham, 2009; Voss, Vesonder, & Spilich, 1980). Future work in this area might tap these skills as well as the ones included in the present study more broadly.

Despite these limitations, however, the present study has been important for research on writing composition in at least three ways. First, this is among the first research studies on Chinese children's writing development. Although the patterns of cognitive correlates in the present study largely matched those found in previous work, some of the dimensions of writing quality may differ in Chinese as compared to some other languages. Ours is a useful example of how to go about this. Second, the present study examined cognitive correlates of writing composition over 4 years altogether. Few, if any, previous research studies have included such long-term cognitive correlates of writing composition. It is interesting to note that one of the unique correlates of writing quality with all variables statistically controlled was age 6 Cross Out, with a raw correlation with writing quality of .45. Such results suggest that early measures of speed of processing by themselves may be useful in predicting subsequent writing skills and, correspondingly, difficulties. Third, the variety of measures included in the present study was fairly comprehensive. This variety allowed us to compare across measures those variables that were most strongly associated with writing quality. This is important for the diagnosis of writing difficulties and for a broad understanding of those variables that may be most important to focus on for promoting subsequent writing skills. In the present study, apart from speed of processing, handwriting fluency and dictation skills emerged as particularly salient in this regard.

Taken together, these results suggest that writing composition in Chinese children represents an important area of inquiry for future study. Given the importance of writing for educational and job success, researchers should continue work in this area by branching out to different additional skills that might promote writing proficiency. A comparison of skills necessary for writing proficiency in a first and a second language may also be useful for this group in future work.

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Table 1

Chinese composition rubric for Hong Kong third grade children

	Score			
	1	**2**	**3**	**4**
Content				
1. Relevance	Mostly or totally irrelevant	Partly relevant	Mostly relevant	Totally relevant
2. Breadth [a]	Very few ideas (1–2 aspects)	Few ideas (e.g., 3 aspects involved)	Some ideas (e.g., 4 aspects involved)	A wide diversity of ideas (e.g., more than 4 aspects)
3. Depth	No elaboration of ideas	An attempt to elaborate on 1 main idea	Occasional rich elaboration on idea(s)	Most ideas are adequately elaborated
Organization				
4. Sentence level organization	Many note-like phrases/incomplete sentences	Many short sentences. Obviously inadequate use of connective/sequencers. OR Ideas are linked in a confusing way in a sentence	Occasional good attempt to link isolated ideas more smoothly with connective/ sequencers	Good use of connectives/sequencers to link ideas effectively
5. Paragraph level organization	No evidence of organizational structure according to ideas. OR Essay too short. No basis to judge	Relevant sentences are partly grouped, but overall, the flow of ideas is not logical enough to be followed with ease	Relevant sentences are mostly grouped. Minor reordering might still be needed for ideas to flow naturally	Sentences are organized effectively to convey meaning naturally and logically
6. Prominence of organizational (key) elements	Topic sentence and conclusion are not present. OR Either topic sentence or conclusion is present but not standing out	Topic sentence is present and easy to identify	Topic sentence and conclusion are present but either or both do not stand out	Topic sentences and conclusion are present and easy to identify
7. Intelligibility	(Almost) impossible to understand. Purpose of writing not accomplished	Need some effort to understand	Fairly easy to understand despite problems in organization/language mechanics	Easy to understand and pleasant to read

[a] Including irrelevant points

Table 2

Special difficulties encountered in a few rating of Chinese compositions

Special cases	Actions
1. Some children regarded pets as toys	The composition was regarded are partly relevant, and the maximum score possible for relevance, breadth, and depth was two
2. Some children wrote too little to be assessed	Maximum possible scores in each dimension were two
3. One composition was totally irrelevant	The student was not penalized in organization and intelligibility. Zero was assigned to relevance. The maximum possible scores for possible breadth and depth were two.
4. Some children elaborated on certain unusual aspects	Because the situation varies, compromise was made in each case regarding the allocation of breadth and depth. Students were not penalized in organization and intelligibility.

Table 3

Inter-rater reliabilities of the seven composition rubric dimensions

Dimension	Inter-rater reliabilities
Relevance	.81
Breadth	.74
Depth	.72
Sentence organization	.74
Paragraph organization	.77
Key elements	.76
Intelligibility	.72

Table 4

Means, standard deviations and correlations among the seven dimensional scores

	1	2	3	4	5	6	7
1. Relevance (*M* = 3.37; SD = .80)	1.00						
2. Breadth (*M* = 2.61; SD = .86)	.14	1.00					
3. Depth (*M* = 2.37; SD = .76)	−.03	.33**	1.00				
4. Sentence organization (*M* = 2.57; SD = .68)	.34	.37**	.60**	1.00			
5. Paragraph organization (*M* = 2.45; SD = .80)	−.00	.47**	.74**	.68**	1.00		
6. Key elements (*M* 2.19; SD = .74)	.12	.38**	.32**	.39**	.40**	1.00	
7. Intelligibility (*M* = 2.51; SD = .76)	.22**	.57**	.71**	.76**	.77**	.42**	1.00

The significance is ** $p < 0.01$

Table 5

Correlations among the five selected dimensional scores and overall writing quality

	1	2	3	4	5	6
1. Depth	1.00					
2. Sentence organization	.60**	1.00				
3. Paragraph organization	.74**	.68**	1.00			
4. Key elements	.32**	.39**	.40**	1.00		
5. Intelligibility	.71**	.76**	.77**	.42**	1.00	
6. Overall writing quality (*M* = 12.09; SD = 3.04)	.83**	.83**	.89**	.62**	.90**	1.00

** $p < .01$

Table 6

Descriptive statistics of ages 6–9 measures, and their correlations with age 9 writing quality

Variables (max possible score)	N	Range	M	SD	Reliability	R Age 9 writing
Age 6	153					
Age in months	153	66–80	73.39	3.47	-	.12
Speeded naming	153	6.40–32.56	14.13	4.11	.86	−.44**
Visual matching	153	76–157	121.63	15.40	-	.33**
Cross out a	153	72–179	125.03	15.28	-	.38**
Chinese dictation (40)	153	1–37	16.45	7.20	.91	.47**
Vocabulary definitions (104)	153	0–51	21.69	8.63	.85	.21*
Phonological Awareness (51)	153	9–51	26.58	7.83	.93	.33**
Age 7	153					
Age in months	153	80–97	88.31	3.89	-	.11
Speeded naming	153	1.00–28.11	12.03	3.62	.83	−.32**
Visual matching	153	81–172	127.74	16.70	-	.39**
Cross out a	153	63–154	122.61	14.53	-	.38**
Chinese dictation (50)	153	1–50	30.68	10.13	.92	.50**
Vocabulary definitions (104)	153	7–72	36.66	12.03	.87	.24**
Phonological Awareness (51)	153	13–51	32.59	9.58	.95	.30**
Age 8	153					
Age in months	153	89–104	97.07	3.45	-	.11
Speeded naming	153	5.21–23.50	10.12	3.09	.87	−.33**
Chinese dictation (96)	153	4–86	51.46	16.70	.96	.54**
Vocabulary definitions (104)	153	8–86	40.04	14.98	.91	.32**
Phonological Awareness (51)	153	8–51	36.44	9.83	.93	.31**
Age 9	153					
Age in months	153	103–117	109.64	3.43	-	.13
Vocabulary definitions (104)	153	11–82	47.12	16.67	.93	.32**

Variables (max possible score)	N	Range	M	SD	Reliability	R Age 9 writing
Handwriting fluency numbers	153	25–74	49.98	11.38	.98	.27**
Handwriting fluency sentence	153	5–28	15.64	3.80	.93	.34**
Overall writing quality (28)	151	7–27.5	18.07	3.74	.89	
Writing: length	151	4–164	69.48	31.73	-	.74**
Writing: Number of words	151	0–12	1.17	1.88	-	−.16*

Cronbach's Alpha reliabilities are reported for Chinese dictation, vocabulary definitions, and phonological awareness. Test-retest reliability is reported for speeded naming, and a Pearson's correlation coefficient is reported as inter-rater reliability for writing and both handwriting fluency measures

* $p < .05$;

** $p < .01$

[a] Standard scores based on an American sample (SD=15, M=100)

Table 7

First-order correlations among all measures controlled for age

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Age 9: writing quality	1.00																					
2. Age 6: speeded naming	−.37**	1.00																				
3. Age 7: speeded naming	−.28**	.57**	1.00																			
4. Age 8: speeded naming	−.33**	.62**	.74**	1.00																		
5. Age 6: cross out	.45**	−.38**	−.29**	−.27**	1.00																	
6. Age 7: cross out	.40**	−.37**	−.38**	−.40**	.56**	1.00																
7: Age 6: visual matching	.31**	−.48**	−.34**	−.23**	.57**	.50**	1.00															
8: Age 7: visual matching	.40**	−.35**	−.38**	−.35**	.49**	.60**	.57**	1.00														
9. Age 6: dictation	.44**	−.30**	−.24**	−.28**	.32**	.28**	.23**	.17*	1.00													
10. Age 7: dictation	.46**	−.24**	−.32**	−.32**	.29**	.33**	.31**	.33**	.60**	1.00												
11. Age 8: dictation	.49**	−.35**	−.38**	−.41**	.29**	.34**	.28**	.36**	.63**	.78**	1.00											
12. Age 6: vocabulary	.16	−.22**	−.08	−.08	.18*	.09	.18*	.03	.20*	.09	.21*	1.00										
13: Age 7: vocabulary	.23**	−.28**	−.14	−.09	.16	.12	.26**	.26**	.29**	.22**	.31**	.30**	1.00									
14. Age 8: vocabulary	.29**	−.30**	−.20*	−.17*	.14	.16	.15	.21*	.18*	.11	.40**	.34**	.37**	1.00								
15. Age 9: vocabulary	.31**	−.27**	−.18*	−.25**	.16	.18*	.18*	.19*	.20*	.33**	.46**	.35**	.35**	.41**	1.00							
16. Age 6: PA	.29**	−.37**	−.28**	−.31**	.27**	.36**	.29**	.16	.38**	.29**	.32**	.21*	.18*	.14	.20*	1.00						

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
17. Age 7: PA	.25**	−.32**	−.29**	−.28**	.29**	.28**	.25**	.19*	.44**	.29**	.30**	.16	.28**	.12	.11	.61**	1.00					
18. Age 8: PA	.28**	−.26**	−.25**	−.28**	.15	.20*	.13	.11	.33**	.27**	.33**	.13	.21*	.25**	.26**	.52**	.61**	1.00				
19: Age 9: HWF (number)	.24**	−.45**	−.32**	−.36**	.20*	.29**	.36**	.33**	.02	.17*	.16	.04	.16	.16	.28**	.21*	.12	.12	1.00			
20. Age 9: HWF (sentence)	.34**	−.36**	−.31**	−.33**	.26**	.22**	.27**	.30**	.11	.26**	.20*	−.04	.11	.13	.24**	.17*	.19*	.18*	.63**	1.00		
21. Age 9: Writing: length	.73**	−.26**	−.14	−.15	.22**	.27**	.25**	.26**	.22**	.35**	.12	.15	.14	.26**	.10	.06	.06	.37**	.34**	.12	1.00	
22. Age 9: Writing: WW	−.17*	.10	.12	.13	−.12	−.20*	−.11	−.16	−.13	−.27**	−.06	−.06	.04	−.13	−.11	−.08	−.06	.00	−.11	−.06	−.05	1.00

PA phonological awareness, *HWF (number)* handwriting fluency task on Chinese numbers, *HWF (sentence)* handwriting fluency task on Chinese sentences, *Writing: WW* number of wrong words in Chinese composition task

* $p < .05$;

** $p < .01$

Table 8

Hierarchical regression equation predicting overall writing quality at age 9

Steps		ΔR^2	R^2	F Change
1.	Age 6: phonological awareness	.35	.35	15.12***
	Age 9: vocabulary definition			
	Age in months at 8 years			
	Age 8: dictation			
Gender				
2.	Age 9: handwriting fluency - sentence	.12	.47	6.11***
	Age 6: cross out			
	Age 7: visual matching			
	Age 6: speeded naming			
	Age 9: handwriting fluency - number			

*** $p < .001$

Table 9

Standardized Betas for the hierarchical regression equation predicting overall writing quality at age 9

Variable	Beta	T
1. Age in months at 8 years	.05	.82
2. Age 8: dictation	.27	3.33**
3. Age 9: vocabulary definitions	.04	.54
4. Age 6: phonological awareness	.07	1.00
5. Gender	.22	3.36**
6. Age 7: visual matching	.05	.70
7. Age 6: cross out	.19	2.48*
8. Age 9: handwriting fluency - Chinese number	−.02	−.24
9. Age 9: handwriting fluency - Chinese sentence	.19	2.34*
10. Age 6: speeded naming	−.12	−1.48

* $p < .05$;

** $p < .01$