Cognitive and linguistic factors affecting alphasyllabary language users comprehending Chinese text

Mark Shiu Kee Shum & Wing Wah Ki
University of Hong Kong
China

Che Kan Leong
University of Saskatchewan
Canada
Chinese University of Hong Kong
China

Abstract

Two groups of 13 to14-year-old alphasyllabary language users (mainly Hindi and Urdu), in integrated or designated school settings (respectively 40 and 48 students), were compared with 59 Chinese students in comprehending 4 elementary Chinese texts, each with three inferential questions requiring short open-ended written answers. Three constructs each with two indicators were hypothesized to predict text comprehension differentially in the three groups: verbal working memory, orthographic processing and sentence processing. The 147 students also completed a short questionnaire on their reading and writing of Chinese, a 43-item Students' Approaches to Learning and a non-verbal general intelligence test. Multivariate analyses of variance and hierarchical multiple regression analyses point to the significant contribution of verbal span working memory, orthographic choice in context and sentence processing in Chinese to Chinese text comprehension. Educational implications include strengthening teaching the structure and function of Chinese characters and words to enhance text comprehension.

Keywords: Chinese text comprehension, alphasyllabary learners, working memory, orthographic, sentence processing

Chinese is the lingua franca for a large number of the world's population and is the foundation for the Japanese morphosyllabic Kanji and the square-shaped Korean Kulja language systems (Daniels & Bright, 1996; Leong & Tamaoka, 1998). Outside of China Chinese is taught as a second (L2) or foreign language (FL) for general purposes in public and private schools and also universities (Linnell, 2001). Linnell also pointed out the challenges and opportunities for teachers of Chinese as L2 or FL in such areas as instructional materials, standardized tests and research particularly within the classroom context. In the present study we examine some of the

factors contributing to simple text comprehension of Chinese as L2 or FL.

Factors Contributing to Learning to Read Chinese

Research in learning Chinese as L2/FL is sparse even though an estimated 30 million people around the world are learning Chinese as L2 or FL (Gunderson, Odo, & D'Silva, 2011, p. 476). We need to turn for guidance to studies of native Chinese speakers learning to read Chinese.

Sub-lexical, Lexical and Sentence Levels

At the sub-lexical level there are studies on using phonological and semantic analogies in training young Chinese children to read unfamiliar Chinese characters (Ho, Wong, & Chan, 1999); on the role and function of phonetic and semantic radicals in reading development in Chinese (Ho, Ng, & Ng, 2003); and on orthographic (intra-character) knowledge in enhancing simple Chinese text comprehension for native and non-native Chinese speakers (Leong, Tse, Loh, & Ki, 2011).

At the character and word level most of the studies relate to morphological awareness. which refers to sensitivity to inter-word relations and applies to compounding, inflection and derivation. In the absence of inflection and derivation per se, morphological awareness in Chinese refers mainly to compounding. Morphological compounding has been shown to affect Chinese children's character reading and vocabulary (Chen, Hao, Geva, Zhu, & Shu, 2009; Liu & McBride-Chang, 2010); vocabulary development and paragraph reading comprehension (Wu et al., 2009); and learning to write Chinese characters through explicit teaching of orthographic and morphemic structure (Packard et al., 2006).

At the sentence level, Yeung et al. (2011) used oral cloze tasks of the kind "My favorite food is _____ ." to gauge first grade Chinese children's syntactic skill in relation to reading. The results showed that syntactic skills of the cloze type accounted for a significant amount of unique variance in sentence and passage reading; and rapid naming of numbers together with morphological awareness and orthographic skills explained a significant amount of Chinese word reading. Chik et al. (2012) also used as sentence processing skills the cloze type tasks, but added word order and connectives to study sentence reading comprehension of Grades 1 and 2 Chinese children. These authors found from their hierarchical multiple regression analyses that syntactic skills (i.e., word order, knowledge of connectives and morphosyntactic structure) in Grade 1 contributed significantly to reading comprehension in Grade 2 after controlling for age, IQ and autoregressive effects of reading-related cognitive skills in Grade 1.

Verbal Working Memory

In addition to the linguistic component skills affecting reading literacy in Chinese as discussed above, cognitive factors are also involved. The main one is verbal working memory. Working memory refers to processing resources of limited capacity that individuals need to maintain information while simultaneously acting on the same or other information. Verbal working memory tasks generally require children to hold increasingly complex verbal information in memory while responding to questions about the tasks. These memory tasks have been shown to

predict school achievement (Pickering, 2006). They have been found to play a critical role in activating and integrating information in text comprehension in typical readers of English (Cain, Oakhill, & Bryant, 2004; Daneman & Carpenter, 1980, 1983; Daneman & Merikle, 1996; Seigneuric & Ehrlich, 2005), in children with reading disabilities (Gathercole, Alloway, Willis, & Adams, 2006), and in secondary students learning English as a foreign language (Kormos & Sáfár, 2008).

These findings also apply to text comprehension in Chinese as shown by Leong, Tse, Loh, and Hau (2008) in their study of inferential text comprehension with an open-ended written answer format in 518 Grades 3 to 5 Chinese children. Using structural equation modeling and hierarchical multiple regression analyses, Leong et al. (2008) found that verbal working memory, together with a small contribution from Chinese pseudoword reading, had a strong and unique effect on Chinese text comprehension.

Motivational Factors

There are also the effects of socio-psychological aspects of motivation on language learning including reading. Wigfield and Guthrie (1997) showed children's motivational dimensions of self-efficacy, intrinsic-extrinsic motivation and social purpose of reading related to the amount and breadth of the children's reading. These dimensions were supported in a confirmatory factor analysis with a much larger sample by Baker and Wigfield (1999). These researchers further confirmed the complex and multi-dimensional aspects of the construct of motivation. Working along similar lines, Lin, Wong and McBride-Chang (2012) have found different types of motivation for reading comprehension in Chinese as first language for 104 Hong Kong Chinese fifth graders.

While these studies are note-worthy, they do not deal with motivation in reading Chinese as L2. Current studies of L2 reading motivation tend to focus on language identity, culture, community and situation-specific motives in language learning within classroom settings (Dörnyei, 1994; Dörnyei & Ushioda, 2011).

To summarize the argument so far, current research literature suggests that similar cognitive and linguistic constructs such as verbal working memory, morphological awareness, orthographic and sentence processing underpin learning to read the morphosyllabic Chinese (Chao, 1968) and the alphabetic English writing systems. However, the effects of these constructs and variables are modulated by the specific characteristics of each writing system.

Users of Alphasyllabaries Learning to Read Chinese

The various linguistic and cognitive factors suggest that learning to read Chinese is a complex task. This task presents even greater challenges for non-Chinese language learners. These learners' small vocabulary and less well developed receptive and expressive language skills impede their development in the second language. In this paper we report on a study of a group of language learners (LLs), as denoted by Durgunoğlu (2002) and Cook (2003), or non-native users (NNUs) of Chinese learning to comprehend elementary Chinese text materials as a FL or

L2 in Hong Kong.

The language users in this report are predominantly of ethnic Pakistani and Indian origin. At home they speak mainly Urdu or Hindi, intermixed with English and some spoken Chinese (Cantonese). Urdu is one of the two official languages of Pakistan, the other being English, and is significantly influenced by English (Schmidt, 1999). It draws its vocabulary mainly from Persian and Arabic, and is written with Kaithi script from right to left. Standard Hindi is conventionally written in Devanagari script with borrowing from Sanskrit and with syllabic and alphabetic properties (Daniels & Bright, 1996; Vaid & Padakannaya, 2004). Most linguists consider Urdu and Hindi to be two standardized forms of the same language because of the identical grammar and core vocabulary (Schmidt, 1999). These alphasyllabaries write each consonant-vowel sequence as a unit in which the obligatory vowel diacritically modifies the consonant (Bright, 1996, p. 384). Learners of Hindi were found to focus on the consonants first, then the obligatory vowel signs written as diacritical marks in the structural spatial and temporal hybridity of the Devanagari script (Patel & Soper, 1987; Vaid & Gupta, 2002; Vasanta, 2004). These studies suggest that in learning to read words in alphasyllabaries children make use of phonological and orthographic representations and older grade school children may be using a mixture of phonological and orthographic strategies according to task demands. The question arises: Would these minority alphasyllabary language users in the majority Chinese speaking community such as Hong Kong be using similar strategies in learning to read the morphosyllabic Chinese?

The Present Study

The present study is an integral part of the research and development program to promote learning of Chinese in Cantonese-speaking Hong Kong by users of alphasyllabary. The program consists of these inter-related components: design of curriculum and teaching materials, workshops and seminars for teachers, and research into teaching and learning processes. The present investigation constitutes the third component of the program, which focuses on the teaching and learning of L2/FL Chinese as "cognition" with attention to the "how of [research] applications as well as the what" (Ellis, 1997, p. 88).

Research Questions

Of the different components affecting Chinese reading we focused on three constructs each instantiated by two indicators: verbal working memory, orthographic and sentential processing (details in Tasks and Procedure section). We were interested in the effect of these constructs or variables on reading comprehension in two groups of NNU students compared with their Chinese controls. One NNUs group was integrated into regular classes and studied school Chinese with their Chinese peers; the other group of NNUs learned Chinese in "designated" schools with a majority of other NNU students (see section on Participants). From the research literature discussed in preceding paragraphs and in-situ observation of the students in their schools, we set up the following research hypotheses/questions.

1. The NNUs would perform differently in reading related tasks in Chinese from their Chinese peers because of the different cultural and linguistic background of these target students.

2. There would be differential performance in the reading-related tasks by the two NNU groups because the designated NNUs likely were later arrivals to Hong Kong and would have less exposure to school Chinese in the designated company of speakers of their own language(s).

3. The three groups would show no difference in their approaches to learning reading Chinese within the broad framework of situation-specific motivation in language learning within classroom settings (Dörnyei, 1994; Dörnyei & Ushioda, 2011).

4. After controlling statistically for length of residence in Hong Kong and their self-professed knowledge of Chinese reading and writing, the integrated NNU students would perform in the various tasks as well as their Chinese peers because of the milieu in the integrated setting. Further, these two groups would outperform the designated NNU students.

Participants

The participants consisted of 40 NNU students from integrated classes or schools (NNUI) (mean age = 14.22 years, *SD* = 1.33 years); 48 NNU students from non-integrated or designated schools (NNUD) (mean age = 13.17 years, *SD* = .68 year); 59 Chinese students (Chi) (mean age of 13.14 years, *SD* = .76 year); and 147 for the total group (mean age of 13.44 years, *SD* = 1.04 years). Those NNUs in non-integrated or designated schools were generally later arrivals in Hong Kong as compared with the NNUIs. Some NNUs opted for designated schools because of more interaction with fellow students with similar culture and home languages of Hindi or Urdu. They followed a tailor-made Chinese curriculum and were provided with additional resources and support. In some contrast, the NNUIs in integrated schools opted for the greater opportunity to learn Chinese. One-way ANOVA found a significant age difference among the groups (F (2, 144) = 19.29, p = .00, η^2 = .21). Pair comparisons showed the difference between NNUI and Chi and NNUI and NNUD was significant (p = .00), while there was no age difference between NNUD and Chi.

Tasks and Procedure

To answer the research questions, we first assessed the students' non-verbal general intelligence and also asked them to complete a questionnaire consisting of two parts as performance of these tasks might have an effect on levels of reading. One part of the questionnaire asked for information on their number of years living in Hong Kong and of learning school Chinese, their home language and their perceived importance in learning Chinese. This part serves as a proxy in estimating the age of acquisition (AoA). AoA has been shown to reflect the order of written word acquisition which in turn reflects the state of the network in recognizing and producing rapidly new words in both first language (Monaghan & Ellis, 2002) and second language (Izura & Ellis, 2002).

The other part of the questionnaire consists of a 5-point scale asking for self-assessment of their ability to listen, speak, read, write to dictation and write short Chinese composition. We then administered tasks tapping the students' non-verbal general ability and their approaches to learning. These tasks were followed by specially designed reading or reading-related tasks conceptualized as constructs, each of which was subserved by multiple indicators: Chinese text comprehension task with 4 short texts, verbal working memory with 2 tasks, orthographic processing with 2 tasks, and sentence processing with 2 tasks. The details of these tasks are described below.

Non-verbal general ability. For assessment of general ability the British Ability Scale (BAS) Matrix D test with 12 items (Elliott, Murray, & Pearson, 1978) was administered to all the students. This is a standardized non-verbal general ability test tapping reasoning by analogy and deduction. Students are asked to complete a pattern of horizontal, vertical, slanting lines; triangular, square, oblong and circular shapes; and partial or full shading based on the principle of deduction of relations and correlates from these parts of the overall pattern. This task took 15 minutes plus discussion time for the sample items, and the raw scores were converted to scaled scores for statistical treatment.

Students' Approaches to Learning. We examined the different scales used by previous researchers on the multi-dimensional motivation for reading (e.g., Baker & Wigfield, 1999; Lin et al., 2012; Wigfield & Guthrie, 1997). We found the well-validated and cross-cultural Students' Approaches to Learning (SAL) scale to be most appropriate for assessing cognitive-affective aspects of academic learning. SAL is based on "OECD's brief self-report measure of educational psychology's most useful affective constructs" (Marsh, Hau, Artelt, Baumert, & Peschar, 2006, p. 311). SAL measures 14 factors assessing self-regulated learning strategies, motivation, self-beliefs and learning preferences. It is derived from the data base of approximately 4,000 fifteen-year-olds from 25 countries in OECD's Program for International Student Assessment (PISA) (OECD, 2001). The 14 factors are reasonably invariant across 25 countries and also between the SAL factors and the variables of gender, socio-economic status, mathematics achievement and verbal achievement (Marsh et al., 2006). Results were also found to support relations among constructs derived from different theoretical frameworks and their cross-cultural generalizability.

From the original 53 items yielding 14 factors those items relating to mathematics learning and achievement were deleted and the remaining 43 items were used for our study. These items were then translated into Chinese and also back translated into English as a check for fidelity. The original English version of the 43 items was given to the NNUs and the translated Chinese version given to the Chinese students to minimize any possible difficulty with language interpretation. The 43-item scale provides a five-point response from 1 meaning strongly disagree to 5 meaning strongly agree. Students would simply mark the 1 to 5 values to indicate the degree of their disagreement or agreement with the statement. The administration of the scale took 10 minutes plus a few minutes for instruction. Some sample items from the original factors are: "I study in order to get a good job" (dimension of motivation); "When I study, I will work as hard as possible" (dimension of learning strategies); "I can learn something well if I want to" (dimension of self-belief) and "I read in my spare time" (dimension of motivation).

Text comprehension. The criterion Chinese text comprehension task was modified and simplified from that used by Leong et al. (2008). From the original 8 essays 4 expository passages with about 100 characters each (*M* = 113) were deemed suitable and rewritten to the level of the NNUs. These essays were on the topics of: "Shutting the Pen after Losing the Goat" (Text 1), "Peanuts" (Text 2), "Pearl of the Orient (Hong Kong)" (Text 3), and "Alfred Nobel" (Text 4). The contents were familiar to the NNUs to ensure that background knowledge would not have an undue effect on comprehension.

The text comprehension task with the 4 passages, each followed by 3 open-ended inferencing (literal, coherence and elaborative) questions, was administered to groups of students as a written task in 40 minutes plus about 10 minutes for a short practice example. The students were told to read silently each printed passage on the top half of each page, to write down on the bottom half of the proforma their written answers to each of the inferencing questions, and not to worry about spelling or grammatical construction in their short answers. The written protocols were scored independently by two members of the research team with high inter-rater fiduciary. Credits of 0, 1, 2 or 3 were awarded for each answer according to its shallowness or depth of the written answers in relation to the inferencing question. Spelling errors and poor grammatical construction were discounted in the scoring. Cronbach's alpha coefficient for the 4 passages was .76. The essay on Peanuts and the questions are shown in the Appendix.

Verbal working memory. The working memory construct was subserved by two tasks: a verbal span working memory task (VSWM) administered orally in Cantonese and an operation span working memory (OSWM) task involving numbers and very simple English words and administered in English to the NNUs and in Chinese to the contrast group of native Chinese students.

The verbal span working memory task (VSWM) was based on the rationale and format of Daneman and Carpenter (1980, 1983) as modified by Swanson (1992). A total of 6 sets of two, three and four sentences, all unrelated in meaning, were read orally by the experimenter to small groups of students. They first listened to each set of two-, three- or four-sentences plus the question, all spoken in Cantonese, and were then to write down on designated forms their short answers to the comprehension question and the last word in each sentence of the set. A verbatim translated example from a three-sentence set is: "I was [under the tree] reading a book. Teacher Chan took the mini-bus to school. Sister was eating ice cream." The answer to the comprehension question "How did teacher Chan get to school [by what kind of transportation]?" should be "mini-bus" [a very common means of transportation in Hong Kong]." And the last words should be: "book [note the reverse order in Chinese], school, and ice cream". The total testing time for this task was 20 minutes and all the answers were scored independently by two RAs. One mark was awarded for each correct answer and the maximum score was 24. Cronbach's alpha coefficient was .81.

The operation span working memory task (OSWM) was modeled after the operation span task of Engle, Tuholski, Laughlin, and Conway (1999). Groups of students heard 6 sets of 3 or 4 sentences, each of which involved very simple mental arithmetic calculation with either a correct or wrong answer and followed by a simple spoken English/Chinese word for the respective NNU and Chinese groups. Students had to wait till the end of each sentence set before writing down on

the designated forms just YES/NO to the answers of the simple calculation and the one word at the end in the correct order. An example of a three-sentence set is as follows: "Is 16 – 9 = 7? (Bear) YES/NO; Is 12 x 2 = 24? (Bus) YES/NO; Is 20 – 6 = 12? (Book) YES/NO." The instruction was spoken in English for the NNU students and in Chinese for the group of 59 Chinese students. The total testing time for this task was 15 minutes. A credit of one was given for each correct answer and the maximum score was 42. Cronbach's alpha coefficient was .81.

Orthographic processing. Grabe (2009, p. 24) refers to orthographic processing in English as "the visual recognition of word forms from the text." A fairly comprehensive definition is from Barker, Torgesen and Wagner (1992, pp. 335-336) who posited orthographic knowledge as involving "memory for specific visual/spelling patterns that identify individual words, or word parts, on the printed page". We operationally defined orthographic knowledge in Chinese as involving the understanding of the positional constraint and the role of intra-character constituents of the semantic and phonetic radicals and their integration. Such knowledge also extends to the inter-character integration to form words. There were two tasks: orthographic choice and orthographic choice in context.

The orthographic choice task required students to read silently and rapidly 20 item-pairs of two-character words printed on a sheet and to circle the one correct real or meaningful two-character words. The original concept was from Olson, Kliegl, Davidson, and Foltz (1985) who used lexical items consisting of one real English word and one homophonic pseudoword with similar word shape (e.g., soap, sope; gawn, gone).

Our 20 pairs of two-character words consisted of: (a) 10 item-pairs of regular consistent characters (characters pronounced the same way as the phonetic radicals in isolation and with the same lexical tone, initials and finals, such as 洋光 (ocean light) 陽光(sunlight)); (b) 5 item-pairs of regular inconsistent characters (characters pronounced the same as the phonetic radicals but with different tones such as 米飯 (rice or cooked rice) 米反 (rice-against, a pseudoword); and (c) 5 item-pairs of irregular or exception characters (characters pronounced with different sounds and tones from the phonetic radicals in isolation such as 直線 (straight line) 直練 (straight practice, a pseudoword word). The total testing time for this task was 8 minutes and the maximum score was 20. Cronbach's alpha coefficient for the Chinese version was .63.

The paper-and-pencil orthographic choice in context task was similar in principle to the orthographic choice task. Groups of students were asked to read silently and rapidly 20 short sentences in Chinese, each embedding 4 two-character words one of which was the correct choice and would complete the meaning of the sentence. The three distractors were orthographically or phonologically similar two-character words of regular consistent, regular inconsistent or exception real or pseudowords. A sample sentence embedding the 4 two-character words is as follows: (花原 / 花源 / 花圍 / 花園) 裏有很多花草。 (In the garden there are many flowers and weeds).The total testing time for this task was 15 minutes and the maximum score for the 20 items was 20. Cronbach's alpha coefficient was .62.

Sentence Processing. In essence, syntactic processing and sentential comprehension involve the integration of these different information sources and are constrained by these linguistic categories: (a) word-level constraints such as grammatical categories, (b) contextual constraints particularly important for the resolution of plausibilities and ambiguities, (c) working memory

capacity and processing efficiency, and (d) phrase structure contexts (Gibson & Pearlmutter, 1998). There were two tasks in this construct, one is on grammaticality and the other on the detection and correction of syntactic errors in short sentences.

In second language learning grammaticality judgment or grammaticalness in language is considered to elicit a particular kind of sentence processing involving word order (Ellis, 1991; McDonald, 2000; Munnich, Flynn, & Martohardjono, 1994). Our interest in the present study was in the linguistic intuition derived from the analysis and control processing (Bialystok, 1999, 2001) of simple sentences, and not in the judgment of gradation of acceptability hierarchies.

We assembled 22 parallel pairs of grammatically correct and grammatically anomalous simple Chinese sentences emphasizing correct word order and syntactic integrity. This is analogous to the English pair (e.g., "The runner turned off the road." vs. "*The runner turned the road off."). Actual sample items included: (你是我最好的朋友。vs. *我最好的朋友你是。Meaning "you are my best friend"); (外面正下着大雨。vs. *正下着大雨外面。Meaning "It is raining outside"). These 22 pairs of sentences were arranged at random on the printed page and administered as a group paper-and-pencil task. The participants were asked to check YES or NO to the grammatically correct or incorrect sentence. One mark was given to the correct choice and the maximum score was 44. This task was from the original reaction time study of grammatical judgment by Leong, Tsung, Tse, Shum and Ki (2011) and the Cronbach alpha coefficient for both the correct and the anomalous sentences was .99.

The aim of the sentence integrity task with 26 short sentences was to tap the learners' implicit understanding of standard modern Chinese and the explicit production of correct sentences. Each of these sentences contains an error which violates syntactic integrity such as anaphoric reference, temporal sequencing, subjacency and other grammatical constraints. The use of "interlanguage" from the alphasyllabary mother tongue or from English likely accentuates imperfect or deficient understanding of word order, or the improper use of semimorphological markers. The latter include such markers as *bei* (被) to denoting negativity, *ba* (把) meaning to hold, the comparator *bi* (比) and other grammatical categories. A typical example of difficulties with *bi* is: *我胖過你 to denote "I am fatter than you" where *bi* should be used: 我 *bi* 你胖. Another example is: 我們被 [*bei*] 人打了。("We are [were] beaten by others") but not with the negation: *我們被 [*bei*]人不打了。("We were not beaten by others.") The semimorphological marker *bei* usually has "unfavorable meanings" according to the eminent linguist Y.R. Chao (1968, p. 703) and the anomalous usage of *bei* is likely the result of translation of the English passive verb "by" (Chao, 1968; Tse, Shum, Miu, & Ki, 2001). The 26 sentences were printed on a proforma sheet and the students were required to detect the errors and write out the short correct sentences. One mark was given for each correctly written sentence and the maximum mark was 26.

Results

Preliminary Analyses of Background Information

We first tested if the 3 groups differed in their non-verbal general ability. The performance of the

students on the British Ability Scale Matrix test is as follows: NNU integrated with 40 students (M = 108.25, SD = 17.82), NNU designated with 48 students (M = 102.67, SD = 25.44), Chinese with 59 students (M = 102.78, SD = 31.14), total of 147 students (M = 104.23, SD = 26.16). One-way ANOVA showed there was no significant difference in the non-verbal general ability of the 3 groups (F (2, 144) = .65, p = .53, η^2 = .01).

Self-evaluation. To test the cohesiveness of the items of the background information on years of living in Hong Kong and self-evaluation of knowledge of school Chinese, they were subjected to a principal component analysis followed by varimax rotation. Two components with eigenvalues > 1 emerged, accounting for 68.79% of the total variation. The first component with an eigenvalue of 3.45 accounting for 49.31% of the variation might be labeled perception of Chinese Reading and Writing (ChiRW). The second component with an eigenvalue of 1.36 explained an additional 19.48 of the variation and might be termed Years Living in Hong Kong (YrHK).

The more parsimonious two sets of components from the principal component analysis were subjected to a 3 (group) x 2 (component) MANCOVA with age as the covariate. Wilks' lambda of 26.56 was significant (p = .00, η^2 = .27). Univariate ANCOVA showed that Component I (ChiRW) was significantly different among the 3 groups (F (2, 143) = 49.64, p = .00, η^2 = .41). Component II was also significantly different among the 3 groups (F (2,143) = 6.39, p = .00, η^2 = .08). For the ChiRW component pairwise comparisons showed that the Chinese students performed significantly better than the NNU groups and there was no difference in the performance between the two NNU groups. For the YrHK component Chinese students did better than those NNUs in designated schools but not those in integrated schools. The latter group performed better than their designated counterparts. The self-report data provided insight into related factors in learning Chinese and an answer to research question No. 4.

Students' Approaches to Learning. The 43 items from the Marsh et al. (2006) SAL scale were subjected to a principal component analysis followed by varimax rotation with a view to deriving a more parsimonious pattern of the structure of SAL. Three components emerged, explaining 70.27% of the variation. Items dealing with dimensions of motivation, learning strategies (memorization, elaboration, control, effort and perseverance, co-operative learning) all loaded on Component I (eigenvalue of 5.87) and accounted for 53.37% of the total variation. This component was labeled Learning Strategies and Motivation. Items dealing with self-concept, perceived self-efficacy and control expectation loaded on Component II (eigenvalue of .94) and accounted for 8.54% of the total variation. Component II was labeled as Self-Belief and Self-Concept. Component III (eigenvalue .92) explained an additional 8.36% of the variation and was labeled Interest in Reading.

A 3 (group) x 3 (component) MANCOVA with age as covariate showed no significant difference among the 3 groups in SAL (Wilkes' Lambda of .72, p = .64, η^2 = .02). Further analysis by adding the two sets of component scores from ChiRW and YrHK also showed no difference among the 3 groups (Wilkes' Lambda of .72, p = .49, η^2 = .01). These results suggest that the 3 groups of students did not differ in their motivation to learn Chinese, their self-efficacy and their interest in reading Chinese. These results from the well validated SAL were encouraging and provided an answer to research question No. 3. With the non-significant results of the

components of Students' Approaches to Learning among the 3 groups SAL was not further pursued in the main analyses.

Main Analyses

The means and standard deviations of the main tasks (4 text comprehension, 2 verbal working memory, 2 orthographic processing and 2 sentence processing) for each group are shown in Table 1.

Table 1. *Means and standard deviations of variables for 40 integrated non-native users, 48 designated non-native users, 59 Chinese students, and the total group of 147 students*

Variable	40 Integrated NNUs	48 Designated NNUs	59 Chinese Students	Total Group of 147 Students
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
Age in Years	14.22(1.33)	13.17(0.68)	13.14(0.76)	13.44(1.04)
Text Com1 (Max 9)	4.55(2.04)	1.10(1.51)	5.81(1.78)	3.93(2.69)
Text Com2 (Max 9)	2.40(2.02)	0.44(0.90)	3.51(1.79)	2.20(2.09)
Text Com3 (Max 9)	4.43(2.04)	0.69(1.21)	4.98(1.40)	3.43(2.46)
Text Com4 (Max 9)	2.28(1.77)	0.40(0.61)	4.00(1.59)	2.35(2.08)
VSWM (Max 24)	18.23(6.97)	4.71(5.49)	19.88(5.27)	14.48(8.99)
OSWM (Max 42)	31.18(4.33)	28.40(8.27)	30.64(5.42)	30.05(6.33)
OrthoC (Max 20)	17.33(2.79)	12.56(3.02)	19.68(0.47)	16.71(3.80)
OrthoCon (Max 20)	12.75(3.88)	6.02(2.02)	19.09(1.63)	13.10(6.11)
Grammar (Max 44)	34.13(6.83)	22.02(4.44)	38.53(8.97)	31.94(10.10)
SenInteg (Max 26)	4.55(4.99)	0.17(0.48)	8.31(7.14)	4.63(6.24)

Note. Text Com 1, 2, 3, 4 = Text Comprehension 1, 2, 3, 4; VSWM = Verbal Span Working Memory; OSWM = Operation Span Working Memory; OrthoC = Orthographic Choice; OrthoCon = Orthographic Choice in Context; Grammar = Grammaticality; SenInteg = Sentence Integrity.

A principal component analysis of the written answers of the 4 compositions x 3 questions each showed one component accounting for 77.83% of the total variation. This suggests that the 4 texts with the total of 12 open-ended questions and answers were quite homogeneous in tapping text comprehension. Accordingly the component scores derived from the component analysis were used to represent the total performance of text comprehension and were used in subsequent analyses.

To answer research questions No. 1 and No. 2 on the differential performance of the 3 groups, MANCOVAs with statistical control for variables showing significant differences among the groups (age, self-perception of Chinese Reading and Writing, and Years living in Hong Kong) were carried out for the 6 indicators predicting text comprehension. Overall Wilks' Lambda of 32.61 was significant for all the 3 groups ($p = .00$, $\eta^2 = .59$). The between-subject effects for all the cognitive and linguistic tasks were all significant.

For verbal working memory MANCOVA showed the 3 groups differed significantly ($F (5, 141) = 51.14$, $p = .00$, $\eta^2 = .65$). Pairwise comparisons found the Chinese group outperformed the

designated group (p = .00) but not the integrated group. The latter performed significantly better than the designated group (p = .00). For operation span working memory MANCOVA showed the 3 groups differed significantly (F (5, 141) = 3.57, p = .01, η^2 = .11). Pairwise comparisons found the Chinese group outperformed the integrated NNUs (p = .04) but not the designated NNUs. There was no difference between the 2 NNU groups.

For orthographic choice MANCOVA was significant (F (5, 141) = 55.86, p = .00, η^2 = .67). The Chinese group outperformed both the integrated NNUs (p = .04) and the designated group of NNUs (p = .00), and the former group outperformed the latter group (p = .00). For orthographic choice in context MANCOVA was significant (F (5, 141) = 162.72, p = .00, η^2 = .85). Again, the Chinese group outperformed the 2 NNU groups (p = .00) and the integrated NNUs did better than the designated NNUs (p = .00).

For grammaticality MANCOVA was significant (F (5, 141) = 33.75, p = .00, η^2 = .55). The Chinese group outperformed the designated NNUs (p = .000) but not those in the integrated group. Those students in the integrated group performed significantly better than those in the designated group (p = .00). For sentence integrity MANCOVA was significant (F (5, 141) =14.21, p = .00, η^2 = .34). The Chinese group outperformed the designated group of NNUs (p = .00) but not the integrated group. The latter group outperformed the designated group (p = .01).

Hierarchical Multiple Regression Analyses

The next step was to assess the relative contribution of the linguistic and cognitive constructs and their indicators to overall text comprehension as criterion. This was represented by the component scores from the principal component analysis of the 4 essays each with 3 inferential open-ended questions. Four separate hierarchical multiple regression analyses were carried out for the 2 NNU groups, the Chinese group and the total group. The order of entry was as follows: (1) age; (2) component scores for perceived Chinese reading and writing (ChiRW), and Years in Hong Kong; (3) verbal span working memory and operation span working memory; (4) orthographic choice and orthographic choice in context; and (5) grammaticality and sentence integrity. These results are summarized in Table 2 for the 2 NNU students and in Table 3 for the Chinese students and the total group of 147 students.

Table 2. *Hierarchical multiple regression for 40 integrated non-native users (upper panel) and 48 designated non-native users (lower panel) with text comprehension component scores as criterion*

Step	Variable	40 Integrated Non-Native Users of Chinese				
		β	t	R	R^2	ΔR^2
1	Age	0.24	1.73	0.04	0.00	0.00
2	Chinese Read &Write	0.02	0.19	0.08	0.00	0.00
	Years in Hong Kong	0.01	0.08			
3	Verbal Span Working Memory	0.25	1.07	0.49	0.24	0.23
	Operation Span Working Memory	-0.09	-0.48			
4	Orthographic Choice	0.37*	1.99	0.54	0.29	0.05
	Orthographic Choice in Context	-0.03	-0.15			
5	Grammaticality	0.20	0.98	0.56	0.31	0.02
	Sentence Integrity	0.23	1.37			
Step	Variable	48 Designated Non-Native Users of Chinese				
		β	t	R	R^2	ΔR^2
1	Age	0.22	1.47	0.04	0.00	0.00
2	Chinese Read &Write	-0.14	-0.92	0.08	0.01	0.01
	Years in Hong Kong	-0.13	-0.82			
3	Verbal Span Working Memory	0.46	2.71**	0.49	0.24	0.23
	Operation Span Working Memory	0.17	0.96			
4	Orthographic Choice	0.23	1.54	0.54	0.29	0.05
	Orthographic Choice in Context	-0.26	-1.41			
5	Grammaticality	0.08	0.51	0.56	0.31	0.02
	Sentence Integrity	0.14	0.96			

Note. $*p < 0.5$. $**p < 0.1$.

Table 3. *Hierarchical multiple regression for 59 Chinese students (upper panel) and total group of 147 students (lower panel) with text comprehension component scores as criterion*

Step	Variable	59 Chinese Students				
		β	t	R	R^2	ΔR^2
1	Age	0.22	1.86	0.20	0.04	0.04
2	Chinese Read & Write	0.10	0.78	0.35	0.12	0.08
	Years in Hong Kong	-0.13	-0.11			
4	Verbal Span Working Memory	0.23	1.17	0.62	0.39	0.27
	Operation Span Working Memory	0.21	1.15			
5	Orthographic Choice	-0.14	-1.31	0.66	0.43	0.05
	Orthographic Choice in Context	0.05	0.39			
6	Grammaticality	0.02	0.14	0.70	0.48	0.05
	Sentence Integrity	0.27	2.13*			

		β	t	R	R^2	ΔR^2
				Total Group of 147 Students		
1	Age	0.15	3.99***	0.09	0.01	0.01
2	Chinese Read & Write	0.03	0.72	0.58	0.34	0.33
	Years in Hong Kong	-0.06	-1.44			
4	Verbal Span Working Memory	0.30	4.02***	0.84	0.71	0.37
	Operation Span Working Memory	-0.04	-0.86			
5	Orthographic Choice	0.18	2.47*	0.89	0.80	0.09
	Orthographic Choice in Context	0.29	3.37***			
6	Grammaticality	0.08	1.25	0.91	0.82	0.02
	Sentence Integrity	0.20	4.07***			

Table 3. continued

*Note. *$p < 0.5$. **$p < 0.1$. ***$p < 0.01$.*

It is interesting to note that the contribution of the constructs and their indicators varied for the groups. For the 40 integrated NNUs orthographic choice made a significant contribution to overall text comprehension. For the 48 designated NNUs it was verbal span working memory that made significant contribution to text comprehension. For the 59 Chinese students sentence processing made significant contribution to text comprehension. For the total group of 147 students, age, verbal span working memory, orthographic choice, orthographic choice in context and sentence integrity all made significant contribution to Chinese text comprehension. Despite the relatively small but defensible sample sizes for the 3 groups (see Khamis & Kepler, 2010) these hierarchical multiple regression results show different patterns of performance by the different groups of students and the total group, and provide further answers to research questions 1 and 2.

Discussion

This study examined the contribution to Chinese text comprehension by three cognitive and linguistic constructs in two groups of thirteen-year-old alphasyllabary non-native users of Chinese and a contrast group of Chinese students. The constructs, each of which was instantiated by two indicators, were: verbal working memory (verbal span working memory and operation span working memory), orthographic processing (orthographic choice and orthographic choice in context), and sentence processing (grammaticality and sentence integrity).

The general finding that the integrated NNU students could perform as well as their Chinese peers in many, if not all, of the reading-related tasks might be attributed to many reasons. One plausible reason might be their being integrated with mainstream Chinese students and therefore might acquire implicitly considerable spoken language (Cantonese) and written modern Chinese. Other plausible reasons might be support from the family. We deduced this from the fact that the parents encouraged their children to attend these integrated schools to enhance their learning of Chinese and from classroom observation (Shum, Gao, Tsung, & Ki, 2011). The finding that the target NNU students and their Chinese peers were equally motivated in reading and writing Chinese and in learning in general as deduced from the SAL scale would provide the impetus for further and better learning of school Chinese.

The results can be summarized as follows. First, the integrated NNUs did not differ in their performance from the Chinese controls in these 3 tasks (verbal span working memory, grammaticality and sentence integrity), and performed more poorly than their Chinese counterparts in operation span working memory, orthographic choice and orthographic choice in context. However, this group of NNUs outperformed their designated NNUs in all tasks except operation span working memory. Second, the designated NNUs performed significantly worse than the Chinese controls in all tasks except operation span working memory. These results provide some answer to the research question of the differential performance of the NNUs.

The self reports suggest the integrated NNUs arrived in Hong Kong at an early age or were born in Hong Kong. They could take advantage of the linguistic and social milieu in learning Chinese. In comparison, the designated NNUs arrived in Hong Kong later and the designated setting might provide a less encouraging environment in learning school Chinese.

The descriptive statistics for text comprehension shown in Table 1 suggest that overall the students found the passages difficult. This was especially so for the designated group of 48 NNU students. In this task students were required to read each passage silently, and to answer the open-ended inferential questions in short written answers (see sample task in Appendix). This format of assessing text comprehension has face validity and is acceptable by teachers and students as recommended by Kintsch and Kintsch (2005). This format was also used successfully by Leong et al. (2008) in their study of text comprehension in 518 Grades 3 to 5 Chinese students. While the open-ended written format has been found to work well, it is not known if the difficulty was in the understanding of the passage, the drawing of inferences, the answers in short written sentences or a combination of all these tasks. Examination of some of the answer protocols shows that the better able students could master the different aspects of the task. The designated NNU students, however, found the task quite demanding.

Verbal working memory. For the verbal working memory construct the overall performance was at 73% (Table 1). MANCOVAs showed the groups differed significantly with the Chinese group outperforming the designated NNU group but not the integrated group, while the latter did better than the designated group. These results are generally in keeping with the findings of previous research (e.g., Cain et al., 2004; Leong et al., 2008; Seigneuric & Ehrlich, 2005; Swanson, 1992). What is not known is whether it is the processing or the storage aspect or a combination of both aspects that might explain the present findings (Alloway, Pickering, & Gathercole, 2006). This needs to be further explored. Since verbal working memory relates to the holding and integration of information, the low performance of the designated NNUs in this task might compound their difficulties in text processing which also involves both lexical knowledge and syntactic processing. The tasks used as indicators of working memory could be further refined and additional tasks such as memory updating could be added. Furthermore, future research should examine the possibilities of working memory training (Klingberg, 2010; Pickering, 2006). There is recent evidence that adaptive, computerized working memory intervention could significantly enhance the reading performance in pseudowords, single words and short text passages of 9- to 11-year-old typically developing children (Loosli, Buschkuehl, Perrig, & Jaeggi, 2012). The feature of such training was the adaptability in matching task difficulty with the actual performance of each student and the provision of performance feedback.

Orthographic processing. The results of the orthographic processing tasks support the findings of Ho et al. (1999), and Leong, Tse et al. (2011) that stable and precise knowledge of word form (orthography), meaning (semantics) and speech sound (phonology) and their integration are central to lexical knowledge and text comprehension. Furthermore, Tong, McBride-Chang, Shu, and Wong (2009) found in their study of early Chinese reading literacy with special reference to spelling that orthographically based errors accounted for 33.3% of the variations in Chinese character identification, word dictation, and reading comprehension after controlling statistically vocabulary and chronological age. These authors stated that "orthographic knowledge… appears to be a stable predictor of early Chinese literacy skills" (p. 447). Our results, found for the designated NNUs and also for the total group of 147 students as a whole, support this view (Tables 2 and 3). We suggest for NNUs and indeed for all learners of Chinese that sustained and systematic teaching of the structure and function of Chinese characters and words is necessary, though not sufficient, for Chinese text comprehension. Our orthographic choice and orthographic choice in context tasks were designed with this pedagogic application in mind.

Take the item-pair of regular inconsistent characters (characters pronounced the same as the phonetic radicals but with different tones) such as 米飯 (rice or cooked rice) 米反 (rice-against, a pseudoword) as an example. To make the correct selection of the two-character word, students need to draw on their knowledge of the lexical tone of spoken Cantonese, which accepts as legal the correct written grapheme and of the left-headed semantic radical 飯 meaning "eat" to denote something edible. Similarly, the orthographic choice in context task makes use of the same logic except for embedding the correct two-character word and the three distractors in a sentential frame. While this sentential context might help both the Chinese and the integrated NNUs who performed at 95% and 70.2% respectively (Table 1), the context might not help the designated NNUs who performed at 30% level. The plausible reason might be due to the designated NNUs' smaller receptive and expressive vocabulary even though the two-character words in context all began with the same first character.

Sentence processing. For the grammaticality task the integrated NNUs and the Chinese students performed at 82.80% and 87.56% respectively while the designated group at 50.05 % (Table 1). The simpler sentence structure and the dichotomous YES/NO answer might have facilitated the performance of the first two groups. Still, the designated group lagged behind in their performance. However, the sentence integrity task proved much more challenging for all 3 groups with the integrated NNUs scoring at 20.56%, the Chinese group at 31.94% and the designated group at .01%. What might be the reasons for this low performance?

The sentence integrity task tapping understanding of syntactic structure was designed to challenge the students. The combined tasks of detecting the syntactic errors, correcting them and writing down the correct versions might be too difficult for all the students especially those in the designated setting. Following the suggestions of Ellis (1997), Linnell (2001), Tse et al. (2001) and others, we scrutinized the written answer protocols and noted some of the sources of difficulties. These are discussed briefly in the following paragraphs.

Syntactically and semantically plausible sentences are one source of difficulty for all Chinese learners. A sentence such as "Visiting relation is fun" can be interpreted according to the phrase structure constraint or Halliday's (2004) constituency analysis with minimum and maximum

bracketing in functional grammar. The topic could either be "relation" or the act of "visiting". A corresponding sentence in Chinese could be: "咬死了 / 獵人的狗 or 咬死了獵人的 / 狗。(literally "[Biting dead] [hunter's dog]" or "[biting dead hunter] [dog]" or "The dog that bites dead the hunter."

Another characteristic of Chinese sentences causing difficulties for non-Chinese speakers is the use of semimorphological markers such as *bei* 被 and *ba* 把 (to hold). These markers are used in the absence of morphological markers such as inflection, tense, number, gender and case. The marker *bei* is meant to express unhappy or unexpected events. An example is: 我恭賀你。 ("I congratulate you") but it is anomalous in Chinese to say *你被 [*bei*] 我恭賀。 ("You are congratulated by me.") The marker *ba* is used in a sentence such as 我把那本書賣了。 ("I [*ba*] that book sold") but this marker cannot be used with negation such as *我把那本書不賣了。 ("I [*ba*] that book not sold").

Our careful scrutiny of the answer scripts of sentential processing and the analysis of written errors are in keeping with the emphasis of Ellis (1997) to understand the what and how of language learning and to study error treatment. This approach emphasizes research, bridges the gap between L2 or FL learning, and provides information for instructional materials (see Ellis, 1997; Linnell, 2001; Tse et al., 2001).

Quantitatively, the hierarchical multiple regression analyses for the 3 groups separately and especially for the overall group of 147 students (Tables 2 and 3) point to the significant contribution of verbal span working memory, orthographic choice in context and sentence processing to Chinese text comprehension. Much more research is needed to learn more about the process of learning Chinese by non-native speakers and to promote teacher development and expertise. CACLER (2011) is striving after these goals.

Limitations and Educational Implications

This could be an early study of these NNUs in learning to read Chinese. As such, it suffers from certain shortcomings. Ideally we would like to know their reading performance in their first language of Urdu or Hindi, but we were not able to obtain this information. The next best we could do was to estimate their Chinese language level from the curriculum and teaching materials devised by CACLER (2011) and our classroom observations. We placed their Chinese language level to be at about that of grade 4. Our specially designed materials were geared to this level. We were also not able to obtain information on home background and socio-economic status of the families because of concerns for privacy. We did the best we could by examining their non-verbal general ability, their Approaches to Learning (SAL) scores, their self-reported ability in reading and writing Chinese (ChiRW) and years of residence in Hong Kong (YrHK). Only the latter two tasks showed a difference among the groups and we incorporated them as covariates in our analyses. For many reasons we were not able to recruit more students; the present sample sizes for the groups may pass muster according to the $n = 20 + 5k$ (k being number of predictors) heuristics proposed by Khamis and Kepler (2010).

For future direction, we suggest strengthening the teaching of Chinese to NNU students in

several areas. One area is sustained, systematic teaching of the structure and function of Chinese characters and words to help text comprehension. This emphasis supports the notion that studying Chinese characters and words in isolation facilitates their identification, while learning them in context enhances the comprehension of meaning (Wang & Leland, 2011). The second area is further development of curriculum and teaching materials using an experiential approach to include modules of daily living, traditional Chinese festivals and topics of interest to young people as exemplified in CACLER (2011). The third area is an attempt to provide adaptive training to enhance temporal memory measures and reading as detailed by Loosli et al. (2012).

To conclude, there are many factors such as motivation and home support that contribute to the learning of school Chinese by users of alphasyllabary (Shum et al., 2001). We have provided some empirical evidence of the complexities of learning components of the language and have also made some practical suggestions.

Acknowledgments

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Appendix A

(Sample item) 閱讀理解 2　花生 Text comprehension Essay No. 2 "Peanuts"

1	父親說：「花生的好處很多，有一樣最可貴：它的果實生長在地裏，
2	不像蘋果那樣，把鮮紅的果實掛在樹枝上，使人一看見就喜愛。花生的枝
3	和葉生長在地上，不能看到有沒有果實，必須挖起來才知道。」
4	父親接下去說：「所以你們要像花生的果實，……」我們談到深夜才
5	散，食品都吃完了。

Father said, "Peanuts have many good qualities. There is one endearing quality: Its fruits grow underground. They are not like apples which hang their bright red color fruits on tree branches to the delight of people. The branches and leaves of peanuts grow above ground. To find out whether there are peanut fruits we must dig them up before we know.

Father went on to say, "You should be like the fruits of peanuts…" We talked till late at night before we parted. All the food was eaten.

請用中文字簡單回答下列各題：
Please write down your answers in Chinese to each of these questions:
1.　花生的果實生長在哪裏？
Where do the fruits of peanuts grow?
2.　為什麼父親希望子女像花生的果實？
Why did father want his children to be like the fruits of peanuts?
3.　你希望自己像蘋果，還是像花生？為什麼？
Do you want to be like apples or peanuts? Why?

About the Authors

Mark S. K. Shum, PhD, is Associate Professor and Head of Division of Chinese Language and Literature, Faculty of Education, University of Hong Kong, Hong Kong, China. He obtained his PhD at the University of Melbourne, Australia. His research and publication are in Chinese language education, subject specific genres and teaching Chinese as a second language. E-mail: mskshum@hkucc.hku.hk

Wing Wah Ki, PhD, is a member of the Centre for the Advancement of Chinese Language Education and Research, Associate Professor of Division of Science, Mathematics and Computing Education, Faculty of Education, University of Hong Kong, China. His research and publication are mainly on variation theory and critical pedagogy in technology, mathematics, language in social and culturally diverse contexts. E-mail: hraskww@hkucc.hku.hk

Corresponding author, Che Kan Leong, PhD, is Distinguished Professor Emeritus, Department of Educational Psychology and Special Education, University of Saskatchewan, Canada and Hon. Professor of Educational Psychology, Chinese University of Hong Kong, Hong Kong, China. His research and publication are in morphological and phonological processing in learning to read English and Chinese and developmental dyslexia. E-mail: chekan.leong@usask.ca