Applied Psycholinguistics **24** (2003), 1–25
Printed in the United States of America
DOI: 10.1017.S0142716403000018

Spelling performance of Chinese children using English as a second language: Lexical and visual–orthographic processes

MIN WANG and ESTHER GEVA
University of Toronto

ADDRESS FOR CORRESPONDENCE
Dr. Min Wang, Department of Human Development, 3304P Benjamin Building, University of Maryland, College Park, MD 20742. E-mail: mw246@umail.umd.edu

ABSTRACT
The present study compared lexical and visual–orthographic processing in the spelling performance of 30 Cantonese Chinese children who are English as a second language (ESL) learners to that of 33 native English-speaking (L1) children. Chinese ESL children showed poorer performance in spelling to dictation of pseudowords than L1 children. The difference between real word and pseudoword spelling performances for ESL children was significantly greater than that for L1 children. Moreover, Chinese ESL children outperformed their L1 counterparts in a confrontation spelling task of orthographically legitimate and illegitimate letter strings. In line with their advantage in spelling visually presented materials, the difference between spelling performance on legitimate and illegitimate letter strings for the Chinese children was significantly smaller than that for the L1 children. These findings are discussed in terms of early transfer of L1 literacy skills in second language literacy acquisition and support for a multiroute reading model.

Recent cross-language and cross-orthography research suggests that visual, phonological, and orthographic differences involve different demands on literacy acquisition in different languages (Chen, 1992; Feldman, 1987; Frost & Bentin, 1992; Henderson, 1982; Leong & Tamaoka, 1998; Perfetti & Tan, 1998, 1999; Shimron, 1993; Taylor & Taylor, 1983; Tzeng & Wang, 1983). One major theoretical framework for discussing differences in reading and writing among alphabetic language systems is the orthographic depth hypothesis (see Frost, 1994; Katz & Frost, 1992). According to this hypothesis, there are differences among alphabetic orthographies in terms of how regularly spelling and phonology can be mapped onto each other. In shallow orthographies, such as Spanish, Italian, and Serbo-Croatian, there is a relatively simple one to one correspondence between letters and sounds. Conversely, in deep orthographies, such as English,

© 2003 Cambridge University Press 0142-7164/03 $12.00

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

there is a more complex or opaque relation between letters and sounds. A large volume of literature has documented the effects of differences in orthographic depth on learning to read and spell in different orthographies (e.g., Cossu, Shankweiler, Liberman, Tola, & Katz, 1988; Durgunoglu & Oney, 1999; Frith, Wimmer, & Landerl, 1998; Geva, 1995; Geva & Siegel, 2000; Goswami, Gombert, & Barrera, 1998; Shimron, 1999). For example, readers of a shallow orthography demonstrate an advantage in phonological awareness over readers of a deep orthography (Cossu et al., 1988). Goswami et al. (1998) found that children who learn to read in a less transparent orthography are more likely to benefit from processing large orthographic units such as rimes than children who learn to read in a highly transparent orthography. In a recent longitudinal study, Wimmer, Mayringer, and Landerl (2000) argue that rapid naming may play a more prominent role than phonological awareness in explaining and predicting individual differences in children learning to read shallow orthographies, such as German, compared to deep orthographies, such as English.

Recent research suggests that the orthographic depth framework can be extended to nonalphabetic writing systems such as Chinese. Chinese is often referred to as a deep orthography (e.g., Hu & Catts, 1998). It is considered a logographic system, or, more accurately, a morphosyllabic system (DeFrancis, 1989; Mattingly, 1992; Perfetti & Zhang, 1995). The basic unit of the Chinese writing system is the character. Each character represents a monosyllabic morpheme and is pronounced as an open syllable. Recent research evidence from both adult and child studies suggests that early phonological activation is involved in Chinese word recognition (Ho & Bryant, 1997a, 1997b, 1997c; Hu & Catts, 1993, 1998; McBride–Chang & Ho, 2000; Perfetti & Tan, 1998; Perfetti & Zhang, 1991, 1995; Shu, Anderson, & Wu, 2000; Tan & Perfetti, 1998). At the same time, research has also demonstrated that the phonetic information in Chinese characters is defined at the syllable level and not at the grapheme–phoneme level (e.g., Leong, 1997; Perfetti & Zhang, 1995). In other words, the phonetic component that is thought to be important in reading a Chinese character maps onto a syllable, rather than onto a phoneme. Therefore, according to Mattingly (1987), Leong (1997), and Perfetti, Liu, and Tan (2000), the Chinese writing system does not possess the segmental structure that is rudimentary to alphabetic writing systems. In particular, the principle of phonological assembly in alphabetic systems, whereby, for example, /k/-/æ/-/t/ is assembled to make /kæt/ in English, does not apply when reading a Chinese character.

Research has shown that due to the logographic nature of the Chinese writing system, graphic information and the requisite visual skills are crucial in learning to read Chinese. For example, Huang and Hanley (1994) showed that a test involving visual, paired associate learning was significantly correlated with the reading performance of children in Hong Kong and Taiwan, but not with that of British children. In contrast, the reading performance of British children was better predicted by their performance on phonological awareness tasks, even after controlling for the effects of IQ and vocabulary. In several experimental studies with Chinese adult readers, graphic or visual information was also found to be critical in Chinese character recognition (e.g., Ju & Jackson, 1995; Leck, Weekes, & Chen, 1995; Weekes, Chen, & Lin, 1998). For example, Leck et al.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

(1995) found that the recognition of a Chinese integrated character relies primarily on visual information. The findings from these studies suggest that it is possible that, compared to alphabetic readers, Chinese readers may draw more upon visual skills in learning to read. Therefore, they may have a potential advantage over readers of alphabetic languages in making use of graphic and visual information. This advantage may also be reflected in cases in which Chinese readers are presented with alphabetic letter strings.

To summarize, Chinese presents an interesting case of learning to read in a deep orthography. Reading Chinese does not require mapping graphemes onto phonemes; instead, it requires attending to characters as whole visual or morpholinguistic units. Graphic information and visual processing skills have been shown to be crucial in Chinese character reading for both adults and children. These unique features of their writing system may have important implications for Chinese readers learning to read a second language (L2) with a different writing system.

READING IN AN L2

In light of comparisons across languages and writing systems, L2 researchers claim that the linguistic and orthographic differences among different language and writing systems affect L2 reading acquisition in adults and that reading skills and strategies transfer from the first language (L1) to the L2 (Akamatsu, 1999; Haynes & Carr, 1990; Koda, 1994, 1999, 2000; Verhoeven, 1990; Wade–Woolley, 1999). A number of adult-based studies have demonstrated the effects of linguistic and orthographic differences in L2 reading for learners with a nonalphabetic L1 background (e.g., Akamatsu, 1999; Brown & Haynes, 1985; Haynes & Carr, 1990; Holm & Dodd, 1996; Jackson, Chen, Goldsberry–Shaver, Kim, & Vanderwerff, 1999; Jackson, Lu, & Ju, 1994; Koda, 1999, 2000; Wade–Woolley, 1999). Results of these studies are consistent with the notion that logographic readers learning to read English tend to rely more on orthographic information for word identification than English readers do. Orthographic processing in these studies refers in particular to the processes entailed in detecting visual–orthographic patterns in written words or retrieving visual–orthographic information in memory, whereas phonological processing refers specifically to the processes of phonological recoding of the written words via grapheme–phoneme correspondences. Haynes and Carr (1990) compared Taiwanese and American undergraduates' visual efficiency skills in making visual same–different decisions on orthographically irregular (i.e., illegitimate) four-letter strings, orthographically legitimate four-letter pseudowords, and real four-letter words. The visual efficiency score was defined as the number of correct responses per minute on each of the stimulus types. As was expected, orthographically illegitimate letter strings were the most difficult to judge and real words were the easiest for both groups. However, the authors' main interest was the extent to which the groups contrasted in efficiency gains when the stimuli were more familiar. They computed "lexicality effect" (word–pseudoword efficiency) and "orthography effect" (pseudoword–letter string efficiency). The results revealed that the Chinese L2 readers benefited relatively little from orthography and rela-

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

tively more from lexicality, compared to their American counterparts. In other words, Chinese readers do not process well-structured, or orthographically legitimate, novel letter strings as efficiently as their English L1 counterparts. At the same time, the performance of Chinese L1 readers on orthographically illegitimate letter strings does not deteriorate as much as that of their English L1 counterparts. (See also Jackson et al., 1994, for a review.)

This orthography effect noted in Chinese adults studying English as a second language (ESL) was also demonstrated by Koda (1987, 1989) with Japanese ESL adults. She found that Japanese ESL readers who were literate in Kanji symbols (borrowed from Chinese) performed better in recalling strings of unpronounceable letters than in recalling strings of pronounceable letters. Koda maintains that phonological coding among Japanese subjects was seriously impaired by phonological similarity, but not by either graphic similarity or unpronounceability. In other words, phonological inaccessibility is less debilitating for logographic readers than for alphabetic readers. Jackson et al. (1994) examined orthographic and phonological processing among adult Chinese ESL readers from Taiwan and also found that native Chinese readers are better able to process orthographic information than grapheme–phoneme correspondences. In line with the other cross-writing system L2 studies reviewed here, these Chinese ESL graduate students were better at orthographic processing than at accessing sound patterns of English words. These findings considered together suggest that logographic readers rely less on phonological information presented in graphemic form to access an orthographic representation. On the other hand, for alphabetic readers, a direct analysis of phonological information from the graphemic form is necessary for encoding the subsequent orthographic lexical representation.

Very few studies have examined lexical and orthographic processing in children learning to read an L2. It would be interesting to see whether similar results from adult-based research could be noted among young ESL readers. English L1 research has shown that reading and spelling pseudowords is often more difficult than reading and spelling real words (e.g., Rack, Snowling, & Olson, 1992). Whether this lexicality effect is relevant to L2 learners has begun to receive increasing attention among L2 researchers. Some researchers suggest that because L2 learners may have limited lexical knowledge in their L2, the effect of lexicality in these readers might not be as strong, at least when the L2 involves a shallow orthography such as voweled Hebrew (e.g., Geva, Wade–Woolley, & Shany, 1993). This hypothesis has been tested in a limited number of studies. Wade–Woolley and Siegel (1997) found that ESL children (including children with a Cantonese background) did not differ from English-speaking children on a real word and a pseudoword spelling task, despite their poor performance on phonological tasks. Furthermore, the ESL children benefited to the same degree as their English L1 peers when spelling frequent real words. In other words, just like English-speaking children, L2 primary level children performed better on spelling familiar real words than unknown pseudowords. This was in contrast to the finding from a study on Chinese ESL adults who demonstrated a stronger lexicality effect in spelling. Holm and Dodd (1996) found that

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

ESL university students from Hong Kong did not differ from the other ESL groups with alphabetic L1 backgrounds in reading and spelling real English words. These ESL groups included Chinese Mandarin readers who were taught Chinese script via a separate alphabetic system known as Pinyin. Hong Kong ESL students were, however, significantly less competent than all other ESL readers on a set of phonological awareness tasks and in reading and spelling pseudowords.

It is worth noting that strategies of teaching Chinese to students vary from one region to another. In Mainland China and Taiwan, students learn to read Chinese via assistance from a separate phonetic system. In Mainland China, children learn Pinyin during the first 10 weeks of the first grade (6–7 years) before beginning to read and write Chinese characters (Shu & Anderson, 1997; Shu et al., 2000). As is the case in Mainland China, children in Taiwan learn another phonetic script, known as Zhu-Yin-Fu-Hao, during the first 10 weeks of the first grade, before any instruction in reading and writing Chinese characters is introduced (see Hanley, Tzeng, & Huang, 1999, for a review). In Hong Kong, however, there is no separate phonetic system such as Pinyin or Zhu-Yin-Fu-Hao to aid children in learning to read Chinese. Children are taught by a whole character approach and rote learning strategies (Ho & Bryant, 1997a, 1997c). New characters are learned by copying and memorization. The teacher reads the new character aloud and explains the meaning. Different teaching approaches in reading Chinese have been shown to affect readers' phonological processing skills differently. Chinese readers who are experienced in using an alphabetic phonetic system such as Pinyin to learn to read are more successful in manipulating speech sounds than those who are literate only in Chinese characters (e.g., Read, Zhang, Nie, & Ding, 1986). Children in Taiwan show significant improvement in phonological awareness after being taught the non-Roman phonetic script, Zhu-Yin-Fu-Hao (e.g., Huang & Hanley, 1997). This effect of different Chinese teaching strategies on phonological awareness is directly relevant to the present study because the Chinese ESL children concerned in this study had an unusual whole-word learning history similar to the children in Hong Kong, and this should have an impact on their learning to spell an alphabetic L2.

The above literature review indicates that Chinese adult readers whose L1 learning experience does not involve assistance from an alphabetic system transfer their logographic L1 literacy experience to alphabetic L2 reading. When the phonological awareness required for reading English has not been developed in their L1, these Chinese readers make use of their L1 literacy experience and rely on a visual whole-word strategy. They demonstrate a strong lexicality effect in reading and spelling English words and experience difficulty in processing novel English pseudowords. However, these ESL readers reveal an advantage in processing visual–orthographic information in written words or letters strings, even when phonological information is not accessible from these stimuli. However, Wade–Woolley and Siegel's (1997) findings with young ESL learners suggest that young Chinese ESL children may perform differently from their older peers when reading and spelling unknown pseudowords, perhaps due to

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

their limited Chinese literacy experience. Therefore, we wondered whether Chinese children transfer their limited L1 literacy experience when they learn to read and spell in English. Does the strong effect of lexicality and visual–orthographic processing, which is observed in adult Chinese ESL readers, generalize to Chinese ESL children when they have only limited knowledge of Chinese characters? These questions motivated the present study.

THE PRESENT STUDY

The present study formed part of a larger longitudinal project that was designed to explore the development of various indices of ESL children's oral language and literacy skills over a 3-year period. Literacy development in ESL primary level children was compared to that of a control group of English-speaking children. The children were followed from Grade 1 to Grade 3. They were tested twice in each grade, once at the beginning of the fall term and again at the beginning of the spring term. The aim of the present study was to focus on examining lexical and orthographic processing of a subgroup of young Cantonese children in learning ESL. These children were tested for this study when they were in Grade 2.

Young L2 children present an interesting case for studying the early impact of L1 literacy exposure on L2 literacy acquisition. It is clear that if there is no L1 literacy exposure, no transfer will be expected. It is uncertain, however, whether any transfer effect will be shown by children with only some L1 literacy experience. A limited experience in reading and writing in their L1 may impose no constraints on young Chinese children in learning an L2. Moreover, because they have limited lexical knowledge in their L2, the lexicality effect may not be evident when spelling unknown pseudowords. At the same time, when processing a set of orthographically illegitimate, unpronounceable letter strings, they may demonstrate a similar pattern to that of English-speaking children. If, on the other hand, a limited L1 literacy experience with a logographic L1 leads to some transfer to L2 performance, we would expect to see a negative transfer on Chinese children's performance in spelling unknown words when lexical access is not present and phoneme–grapheme conversion rules are required to produce the correct spelling. However, some positive transfer can be predicted in Chinese ESL children's performance in spelling unpronounceable letter strings. Such a result would be consistent with Koda's (1987, 1989) finding with Japanese ESL adult readers.

In this study we were also interested in examining the possible joint effect of lexicality and specific transfer related to L1–L2 contrastive elements. Recent research suggests that one important L1 transfer is due to the specific contrastive linguistic elements of the L1 system; for example, the absence of the phonological units such as *sh* (/ʃ/) or *th* (/θ/) in Cantonese leads to difficulty for young Chinese children in learning to read and spell these sounds in English (Wang & Geva, in press). Cantonese does not have consonant clusters, either (see Holm & Dodd, 1999, for a detailed comparison of English and Cantonese phonology).

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Therefore, comparing spelling performance between English-speaking and Chinese-speaking children on these contrastive elements in a pseudoword spelling task tests for a joint effect of lexicality and specific L1-related transfer.

METHOD

Subjects

The present study focused on 63 Grade 2 children from eight public elementary schools in two multiethnic suburbs of Metropolitan Toronto. Thirty of them (17 girls, 13 boys) were Chinese children whose L1 was Cantonese. They had been designated as ESL students by the school board, the school, and their teachers. The mean age at the time of testing was 7;3 (range = 6;9–7;10). According to Johnson and Newport (1989), this is an optimal age for L2 children to learn English as an L2. The remaining 33 participants (20 girls, 13 boys) were native English–speaking children. Their mean age at the time of testing was 7;4 (range = 6;10–7;10).

Ninety percent of the Chinese children were born in Canada. The remaining 10% came to Canada with their families between the ages of 3 and 5 years. An important feature of all of the Cantonese families whose children participated in the study was that English was not spoken at home. The children were exposed to Cantonese in the home environment, including media such as TV, radio, and newspaper. All of the families lived almost exclusively in suburban Chinese communities, where they shopped, dined, and entertained in their L1. At age 4, the majority of these children (about 83%) attended kindergartens operated by Chinese communities, where they began to receive Chinese literacy education until they entered elementary school. Starting from Grade 1, all but three of the children received instruction in reading and writing Chinese in weekend Chinese heritage language schools. The three children who did not attend weekend Chinese classes went back to Hong Kong during the summer to enroll in an intensive Chinese learning program. About 73% of the children received private after-school tutoring classes offered by Chinese instructors on school subjects such as math (Lam, 1999). They attended the weekend heritage classes once a week for 2 hr. Homework was assigned for children to practice reading and writing at home during the week. The weekend Chinese school borrows directly from the Hong Kong Chinese language curriculum by adopting the same textbooks used in Hong Kong Chinese language curriculum. Teachers in these heritage classes are mostly immigrants from Hong Kong who used to be Chinese language teachers in their homeland. Of the 2 hr, 1 hr is devoted to reading practice and 1 hr to writing practice. The traditional Hong Kong instructional approach to reading and writing is strictly adhered to in these schools. The characters are taught through rote learning and the children are required to copy each new character 10 times. The test of the mastery of these characters normally involves dictation and cloze exercises. By the end of Grade 1, children in the heritage classes have normally mastered about 100 characters. In Hong Kong the children are able to read 460 different characters by the end of Grade

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

1 (see Ho & Bryant, 1997a, 1997c, for a review). The Chinese literacy level of the immigrant children is therefore far below that of their native peers (M. Lam, personal communication, 2001).

MEASURES

Spelling tasks

Real word spelling. The developmental spelling task was used to assess emergent spelling in English and examine children's knowledge of phonological and orthographic elements and word patterns in familiar English words. The test consists of 16 simple and highly frequent words (see Appendix A). In this task, we were interested in comparing Chinese- and English-speaking children's performance in spelling these words when lexical information is accessible. These words included orthographic representations of certain morphological structures such as plural forms (e.g., cats), tense forms (e.g., wanted), and certain phonological patterns such as long vowels (e.g., please) and consonant digraphs (e.g., ship). The child heard the word in isolation first, and then the target word was repeated in a sentence context. This was followed by another repetition of the target word. An overall measure of absolute accuracy was taken where the word was scored as either correct or incorrect according to the rules of conventional spelling and the percentage of correctly spelled words was calculated. The internal consistency reliability coefficient for this task is .91 based on the Cronbach alpha method.

Pseudoword spelling. In order to examine the impact of lexical knowledge on spelling performance, a list of 16 one-syllable, four-letter pseudowords with a consonant–vowel–consonant–consonant (CVCC) or consonant–consonant–vowel–consonant (CCVC) structure was used. The items and their pronunciations are listed in Appendix B. Pseudoword spelling has been shown to be an effective measure of children's phoneme–grapheme mapping skills (e.g., Rack, Snowling, & Olson, 1992; Treiman, 1993). The child was first introduced to a puppet friend, named Nupi, who is from the planet Neptune and speaks Neptunese. The puppet wanted the child to try and learn some Neptunese. He was going to say some words in Neptunese, then the child was asked to write them down on a piece of paper. One practice item was given.

To control for orthographic and phonological complexity, items containing two consonant digraphs, *sh* (/ʃ/) and *th* (/θ/), and two consonant clusters, *st* (/st/) and *sp* (/sp/), were included in this task. Each of these elements appeared at the initial or final positions of the words across the list. There were two items for each element and each position. The phonemes /ʃ/ and /θ/ and consonant clusters *st* and *sp* are not available in Cantonese. These elements provide an opportunity to test the possible joint effect of lexicality and specific contrastive L1 transfer.

Four vowels were involved in this task: /ɑ/ (*o* as in *dot*), /ɛ/ (*e* as in *bell*), /ʌ/ (*u* as in *bug*), and /ɪ/ (*i* as in *bit*). (The phonetic symbols used in this article follow the International Phonetic Alphabetic; International Phonetic Associa-

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

tion, 1996.) Six graduate students and postdocs from the Learning Research and Development Center at the University of Pittsburgh who specialize in language and reading were asked to provide the possible spellings and assess how common each was for these four vowels. Results indicated that each of the four vowels has a most common spelling: /ɑ/ is most commonly spelled as *o*, /ʌ/ is most commonly spelled as *u*, /ɪ/ is most commonly spelled as *i*, and /ɛ/ is most commonly spelled as *e*. These graduate students also rated both *v* and *ve* as correct spellings for pseudowords ending with the /v/ sound. Children's spellings in this task were scored based on the accuracy of the onset cc cluster, vowel, and coda cc cluster. Less common spellings such as *ea* for /ɛ/ were also scored as correct. Only spellings where all three components of a pseudoword were accurate were given a point. The percentage of correctly spelled items was calculated. The internal consistency reliability coefficient for this task is .88 using the Cronbach alpha method.

Confrontation pseudoword spelling. In this task the child was first introduced to a puppet friend, Nupi. The same information about this puppet provided in the pseudoword spelling task was provided here too, except this time the puppet was going to show the child some Neptunese words and ask the child to write them down on paper. This task was designed to tap into children's visual–orthographic memory skill of the written letter strings and to assess whether this skill relies on phonological accessibility of the stimuli. The child was shown one item at a time for 2 s, and was instructed to pay close attention to the item. There were 12 items in total, each printed on a separate index card. Six of these items were orthographically legitimate, pronounceable pseudowords and 6 were orthographically illegitimate, unpronounceable letter strings. For the orthographically legitimate items, a CCVC or CVCC structure was employed. Again, to control for orthographic and phonological complexity, the same two consonant digraphs (*sh* and *th*) and one consonant cluster (*st*) used in the pseudoword spelling task were used (see Appendix C). Each element appeared twice at the initial position and twice at the final position of the items. One practice item was provided. The scoring was 1 point per correct spelling. Note that the six pronounceable pseudowords were common to the pseudoword spelling and confrontation spelling tasks. In order to avoid any learning effect, the confrontation spelling task was always administered at a different session from the pseudoword spelling task. The order of administration of the two tasks was counterbalanced across the subjects.

The unpronounceable letter strings were orthographically similar to the ones that were pronounceable, except that the vowels in the pronounceable items were replaced by visually similar consonant letters. For example, to create an unpronounceable letter string corresponding to the pronounceable pseudoword *poth*, *c* was used to replace the *o* in *poth*, resulting in *pcth*. These two items are similar to each other in terms of their visual–orthographic pattern, except that one is pronounceable and the other is not. It is important to note that this control of visual similarity between the pronounceable and unpronounceable items was not available in the studies by either Hayes and Carr (1990) or Koda (1987, 1989). We believe that this control is crucial in order to rule out the alternative

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

explanation that the difference in performance on pronounceable and unpronounceable items might come from visual dissimilarity. Hence, we predicted that if the child's performance on this task is driven by visual or graphic processing of the letter strings, then his or her performance on pronounceable and unpronounceable items should not differ dramatically, because of the visual–orthographic similarity of the two sets of items. However, if the child's spelling is achieved through a phonological recoding, then the child should show great difficulty in spelling unpronounceable letter strings, as no phonological information is available on these items. The internal consistency reliability coefficient for this task is .84 using the Cronbach alpha method.

Spelling selection. The purpose for including this task was to assess the child's ability to visually recognize the correct spelling of words and thus to provide converging evidence for the differences between the two language groups of children on visual–orthographic processing of English words. The child was required to listen to a word and then select the word that matched the auditory stimulus from a matrix of four written stimuli. The 100 spelling items of the Peabody Individual Achievement Test–Revised (PIAT-R) (Markwardt, 1989) were used. However, the written stimuli were presented on a laptop computer. A female native English speaker recorded the audio stimuli. The child's task was to point to the word on the computer screen that matched the auditorily presented word. The experimenter recorded the child's answer both on the computer and on the response sheet. Each set consisted of a target word of high frequency and three distracters. The distracters varied in terms of the initial consonants, the final consonants, or the vowel units. One point was given for each correctly selected spelling, and the percentage of correct items was calculated.

Vocabulary measure. The Peabody Picture Vocabulary Test–III (PPVT-III; Dunn & Dunn, 1997) was used as a measure of receptive vocabulary. The measure was used to provide information on children's oral English proficiency level and to establish the Chinese children's L2 status. The child was asked to point to the picture corresponding to the vocabulary word given. One point was given for each correct item and the percentage of correct items was calculated.

Nonverbal ability test. The Matrix Analogy Test (MAT, Expanded form; Naglieri, 1985) was used to control for nonverbal ability when comparing Chinese and English L1 children's spelling performance. The MAT scores were treated as a covariate in the analyses in which visual–orthographic processes are thought to be involved. This treatment is necessary to strengthen the L1 transfer argument by controlling for the possible advantage of high nonverbal skills in Chinese children. There is enough evidence in the literature to suggest that Chinese subjects across different ages have stronger nonverbal skills than their English-speaking counterparts on tests such as the Raven's Matrices Test, which is similar to the MAT used in the present study (Chan & Vernon, 1988; Court, 1991; Huang & Hanley, 1994). The MAT included 64 abstract designs of the standard progressive matrix type. The child was shown a picture with a missing

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

piece in it and asked to choose one from five options to complete the pattern. He or she was allowed to either point or say aloud the number of his or her answer. Standard scores were used for this test.

Procedure

All the test materials except the spelling selection and MAT tasks were administered individually to each child at the beginning of the fall term of Grade 2. The spelling selection task was administered at the beginning of the spring term in Grade 1 and again in the spring term of Grade 2; in other words, two spelling selection scores were obtained longitudinally. The MAT was administered at the beginning of the spring term in Grade 1. At each testing time, all the tests were distributed across four testing sessions, along with other measures related to the larger longitudinal project. The order of administration of the pseudoword spelling and confrontational spelling tasks was counterbalanced across the subjects.

RESULTS

With the exception of the MAT, raw scores were not converted to percentiles or standard scores in order to avoid bias associated with using norms standardized on English L1 populations. Standard scores on the MAT were used based on the assumption that there would be little bias resulting from L1-based normalization on this test. To control for type I error, we set the α level at .01 for each of the following analyses. Only one child in the whole sample was judged to be an outlier, with the scores on most of the measures lower than the group mean by more than 2 standard deviations. The data of this child were not included in subsequent analyses. The means and standard deviations for L1 and ESL children on each test are shown in Table 1.

Performance on vocabulary and nonverbal tests

Separate analyses of variance (ANOVAs) were conducted on the PPVT-R and MAT. English L1 children performed significantly better than Chinese ESL children on the PPVT-R, $F\ (1, 60) = 12.75$, $p < .01$. The low score on the vocabulary test by Chinese children is expected due to their L2 status. This result is consistent with findings from other ESL groups (e.g., Geva, Yaghoub–Zadeh, & Schuster, 2000). MAT scores, on the other hand, showed a different picture. Chinese ESL children performed much better than the L1 children, $F\ (1, 67) = 25.28$, $p < .001$.

The effect of lexicality on spelling (real words vs. pseudowords)

In order to test whether unknown pseudowords are more difficult for children to spell than familiar real words and whether English L1 and Chinese ESL children differ in spelling performance on these two tasks, a 2×2 ANOVA was conducted with language group as the between-subjects variable (L1 vs. ESL)

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Table 1. *Summary statistics for vocabulary, nonverbal ability, and spelling tasks of English L1 and Chinese ESL children*

	L1 (n = 32)	ESL (n = 30)
PPVT-R (%)	47.05	39.54
	(6.93)	(9.51)
MAT standard score	99.94	113.15
	(11.57)	(10.18)
Real word spelling (%)	45.12	60.42
	(25.73)	(32.51)
Pseudoword spelling (%)	44.14	21.67
	(27.22)	(22.85)
Conf. pseudo. spelling (%)	44.53	79.72
	(25.10)	(16.48)
Spelling selection (%)		
Grade 1	33.71	40.21
	(8.91)	(13.37)
Grade 2	43.86	57.55
	(9.70)	(14.71)

Note: PPVT-R, Peabody Picture Vocabulary Test–Revised; MAT, Matrix Analogy Test; Conf. pseudo. spelling, confrontation pseudoword spelling. Standard deviations are in parentheses. The PPVT-R, real word spelling, and pseudoword spelling tasks were administered in the fall term of Grade 2. The spelling selection task was administered in both the spring term of Grade 1 and the spring term of Grade 2. The MAT was administered in the spring term of Grade 1.

and lexicality as the within-subjects variable (real vs. pseudoword). Main effects in the expected direction were found for lexicality, F (1, 60) = 54.95, $p < .001$, but not for language group, F (1, 60) = .32, $p > .5$. On the whole, regardless of language group, children produced more accurate spellings on real words than on pseudowords. The interaction between language group and lexicality was also significant, F (1, 60) = 49.68, $p < .001$. Post hoc t tests showed that the performance on real word spelling did not significantly differ between the groups, t (60) = −2.06, $p > .05$. Chinese children performed significantly more poorly than L1 children on the pseudoword spelling task, t (60) = −3.51, $p < .01$. The L1 means on real and pseudoword spelling did not differ, but ESL children spelled real words significantly more accurately than pseudowords: t (31) = .31, $p > .7$ for L1 children; t (29) = 8.89, $p < .001$ for ESL children (see also Figure 1A).

The two consonant digraphs (*sh*, *th*) and two consonant clusters (*st*, *sp*) involved in the pseudoword spelling to dictation task are phonological structures that are absent in the L1 phonology of the Chinese ESL children. In order to address a joint effect of lexicality and specific L1-related transfer, a further

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

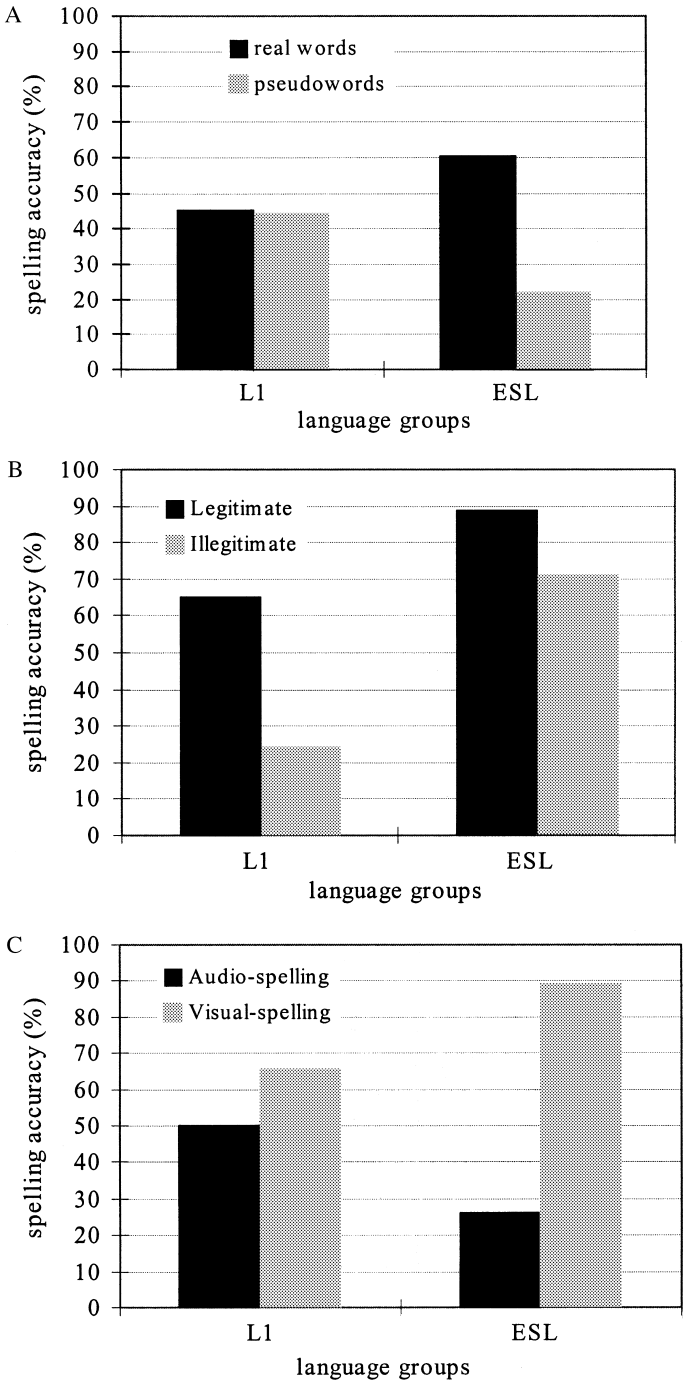


Figure 1. The effects of (A) lexicality, (B) orthographic legitimacy, and (C) visual presentation on spelling performance of Chinese ESL and English L1 children.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Table 2. *Means and standard deviations of error frequency in spelling sh, th, st, and sp in the pseudoword spelling task*

	L1 (n = 32)	ESL (n = 30)
sh	1.16	1.47
	(1.57)	(1.59)
th	1.69	2.60
	(1.49)	(1.45)
st	1.25	1.73
	(1.39)	(1.51)
sp	1.63	1.80
	(1.39)	(1.35)

Note: The score ranges from 0 to 4. Standard deviations are in parentheses.

analysis was carried out on the children's spelling accuracy of the two consonant digraphs and two consonant clusters. Means and standard deviations of error frequency on the *sh* and *th* digraphs and the *st* and *sp* clusters in the pseudoword spelling task are listed in Table 2. The results of two separate repeated measures ANOVAs, where the between-subjects variable was the language group and the within-subjects variable was the two digraphs or two clusters, showed that there was a significant digraph type effect, F (1, 60) = 20.20, $p < .001$. Children produced significantly fewer spelling mistakes on *sh* than *th*. The language group effect was not significant, however, F (1, 60) = 3.22, $p > .05$. The interaction between language group and digraph type was not significant, either, F (1, 60) = 2.64, $p > .1$. Children in general had more difficulty in spelling *th* than *sh*, but the language groups did not differ from each other in spelling *sh* and *th* in the pseudowords. With regard to the two consonant clusters, the group effect, the consonant cluster type effect, or their interaction was not significant (all Fs < 3, all ps > .1).

The effect of orthographic legitimacy on spelling

As described earlier, the confrontation spelling task consisted of two groups of items. One involved orthographically legitimate, pronounceable letter strings and the other involved orthographically illegitimate, unpronounceable letter strings. The means and standard deviations of correct responses on the two groups of items are listed in Table 3. In order to examine the effect of orthographic legitimacy of children's spelling, a repeated measures ANOVA was conducted; the between-subjects factor was language group (L1 vs. ESL) and the within-subjects factor was orthographic legitimacy (legitimate vs. illegitimate). Results showed that there was a significant language effect, F (1, 59) = 77.03, $p < .001$. Overall, Chinese ESL children performed better than L1 children in this confrontation spelling task. The effect of legitimacy was significant

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Table 3. *The effect of orthographic legitimacy on spelling* (*means and standard deviations*)

	L1 (n = 32)	ESL (n = 30)
Legitimate	3.91	5.33
	(1.61)	(0.88)
Illegitimate	1.44	4.24
	(1.76)	(1.60)

Note: The score ranges from 0 to 6. Standard deviations are in parentheses.

as well, F (1, 59) = 77.03, $p < .001$. Children performed better on spelling legitimate letter strings than illegitimate ones. Results also showed that there was a significant interaction between orthographic legitimacy and language group, F (1, 59) = 12.06, $p < .002$. A post hoc t test showed that the difference between accuracy scores in spelling legitimate and illegitimate items in the L1 group was much greater than in the ESL group, t (59) = 3.47, $p < .002$, and the Chinese children performed much better than the L1 children on both orthographically legitimate, pronounceable letter strings and orthographically illegitimate, unpronounceable letter strings, t (59) = –4.29, $p < .001$ and t (59) = –6.50, $p < .001$, respectively (see also Figure 1B).

One may argue that the better performance by Chinese children on spelling illegitimate, unpronounceable letter strings might be due to their high nonverbal ability, as shown in their high MAT scores. In order to address this alternative explanation, an analysis of covariance (ANCOVA) was conducted with the MAT scores as a covariate. The results indicated that even when the effect of nonverbal ability was covaried, the advantage of Chinese ESL children still held for the effects of language, F (1, 58) = 29.27, $p < .001$; orthographic legitimacy, F (1, 58) = 24.20, $p < .001$; and the interaction between them, F (1, 58) = 10.73, $p < .01$.

The effect of visual versus auditory presentation

Six orthographically legitimate items were common to the pseudoword spelling task (i.e., auditory presentation) and the confrontation pseudoword spelling task (i.e., visual presentation). The means and standard deviations of correct spelling of these items are shown in Table 4. A repeated measures ANCOVA was conducted to examine differences between the two language groups on the spelling of these common items. For the same reason as in the test of the orthographic legitimacy effect, nonverbal scores (MAT scores) were treated as a covariate in this analysis. Results showed that the effect of spelling mode (auditory or visual presentation) was significant, F (1, 59) = 23.02, $p < .001$. Children were significantly more accurate when spelling visually presented stimuli than auditorily presented stimuli. The effect of language group was not significant, F (1, 59) =

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Table 4. *The effect of presentation modality on spelling pseudowords* (*means and standard deviations*)

	L1 (n = 32)	ESL (n = 30)
Audio–spelling	3.00	1.57
	(1.79)	(1.68)
Visual–spelling	3.91	5.33
	(1.61)	(0.88)

Note: The score ranges from 0 to 6. Standard deviations are in parentheses.

1.23, $p > .2$ (see also Figure 1C). However, the interaction between language group and spelling mode was significant, F (1, 59) = 31.64, $p < .001$, and a post hoc t test revealed that the difference between the correct spellings on these two tasks was significantly larger for Chinese ESL children than for L1 children, t (60) = −6.58, $p < .001$. This indicates that Chinese ESL children received more benefit from visual presentation of the pseudowords compared to auditory presentation than L1 children, after controlling for their nonverbal skills.

Performance on spelling selection

The spelling selection task can be thought of as another way of testing visual–orthographic processes. A repeated measures ANCOVA revealed a main effect of time on the spelling selection task (PIAT-R) from Grade 1 to Grade 2, F (1, 54) = 21.82, $p < .001$, and a significant effect of language group, F (1, 54) = 9.34, $p < .01$, after controlling for MAT scores. As was the case with the confrontation pseudoword spelling task, Chinese children performed better than L1 children on this task, pointing to stronger visual–orthographic recognition skills. There was also a significant interaction effect between time and language group, F (1, 54) = 5.72, $p < .03$. Post hoc t tests indicated that both L1 and ESL children significantly increased their correct spelling selection scores from Grade 1 to Grade 2 (both ps < .001), but Chinese children gained more over time than L1 children (see also Figure 2). This result is consistent with the notion that Chinese L2 readers are stronger than English L1 readers in processing orthographic information in reading when they visually encounter the words, as was the case in this spelling selection task.

DISCUSSION

Observations made in this study about lexical and orthographic processing in Chinese ESL children's spelling performance add important evidence to the existing, adult-based literature concerning the effect of L1 transfer on L2 acquisition. It provides promising evidence for both positive and negative transfer in early spelling performance of children with some experience in a logographic L1.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

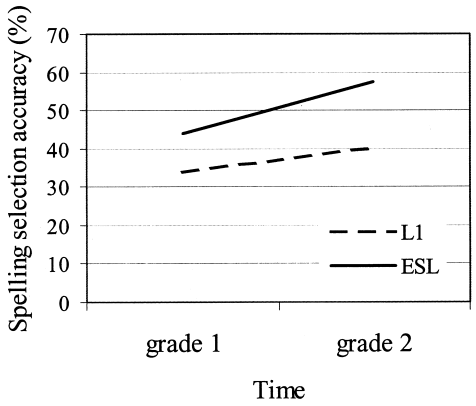


Figure 2. The spelling selection accuracy across time by Chinese ESL and English L1 children.

The effect of L1 negative transfer was noted in the pseudoword spelling to dictation task, on which Chinese ESL children performed more poorly than L1 children. However, the two language groups did not differ significantly in real word spelling. Moreover, the difference between real word and pseudoword spelling performance was much greater for Chinese children than L1 children. The fact that there was no significant difference in the English L1 group between spelling real words and pseudowords can be explained by the fact that the pseudowords were designed to have regular orthographic structures and the spelling of the vowels was relatively regular and consistent. Even with this relatively nondemanding spelling task, the performance of Chinese children was severely impaired. This finding is consistent with that of Holm and Dodd (1996), who report that Chinese ESL adult readers from Hong Kong did not differ from English L1 readers on real word spelling but performed much more poorly on pseudoword spelling. The results from the present study provide converging evidence for the strong lexicality effect in L2 readers with a logographic L1 system background. Chinese ESL children could spell familiar and known words as well as English L1 children could. Our explanation is that when spelling familiar and known English words Chinese children can rely on a direct and nonphonological route or the "addressed phonology" route (Besner & Smith, 1992), which is what they have acquired and practiced in their L1 reading and writing activities (Holm & Dodd, 1996). As pointed out earlier, when Cantonese children are taught to read and write in Chinese, a whole-word, visual, and rote learning strategy is employed (Hanley et al., 1999; Ho & Bryant, 1997a, 1997c). This study is the first to show that even without an intensive school-based, daily exposure to Chinese script, it is possible to observe facilitation in the processing of whole-word information. These young Chinese L2 learners seemed to transfer their L1 reading strategy to spelling in English. When spelling unknown dictated pseudowords, however, these Chinese L2 learners encountered difficulty in carrying out phoneme to grapheme conversion; in other words, they experienced difficulty in mapping the phonemes to graphemes in spelling. This result is

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

consistent with the findings in the literature on the low level of phonemic awareness in Chinese ESL adults, particularly Hong Kong ESL students, caused by their lack of exposure to an alphabet in learning their L1 (e.g., Holm & Dodd, 1996; Jackson et al., 1994). We have evidence from a recent study showing that Chinese primary level children have difficulty in contrasting English phonemes such as "noff" versus "noss" in an auditory discrimination task (Wang & Geva, in press). With increasing exposure to English literacy education from schooling, we expect that these Chinese children would overcome the difficulty in applying grapheme–phoneme correspondences to their spelling of unknown pseudowords.

The findings that young Chinese ESL readers may rely on the addressed phonology route in spelling real words and the assembled phonology route in spelling unknown pseudowords from dictation seems to provide support for the multiroute model of reading and spelling (Besner & Smith, 1992; Coltheart, 1978; Coltheart, Curtis, Atkins, & Haller, 1993). There has been controversy in the literature concerning whether reading behavior can be better explained using a single-system model (e.g., Seidenberg & McClelland, 1989) or a multiroute model. For example, under the framework of the dual-route model, research in L1 has uncovered two distinct reading and spelling styles: lexical (or whole-word) and sublexical (or letter-sound based) patterns among adults and children as well as among normally achieving and poor readers and spellers (e.g., Baron, 1979; Castles & Coltheart, 1993, 1996; Castles, Holmes, & Wong, 1997; Coltheart, Masterson, Byng, Prior, & Riddoch, 1985). The performance of the Chinese ESL children in the present study presents an interesting case in support of the existence of different routes in reading and spelling an L2. The pattern of real word spelling and spelling selection results produced by the Chinese ESL children demonstrated the characteristics of lexical spellers. They appeared to rely heavily on lexical access of the words in spelling. We suggest that the nonlexical or sublexical route is severely impaired in these children due to the negative transfer from their experience in learning to read and write Chinese characters.

The result showing that the two language groups did not differ significantly from each other on spelling the two consonant digraphs and two consonant clusters failed to support the specific L1-related transfer. It is worth noting that these children were tested when they were in Grade 2. These same children, however, did demonstrate difficulty when they were in Grade 1 in spelling these L1-specific linguistic units (Wang & Geva, in press). Therefore, we suggest that the L1-specific transfer might occur only early in their learning of an L2. By the time the children reached Grade 2, the effect of negative transfer related to the absence of certain phonological units, for example, *th* and *sh* in their L1 did not affect the Chinese ESL children's spelling performance on these units.

Promising evidence of positive transfer comes from the results pertaining to the confrontation pseudoword spelling task. Chinese ESL children outperformed L1 children in spelling visually presented orthographically legitimate, pronounceable letter strings and orthographically illegitimate, unpronounceable letter strings. Recall that the pronounceable and unpronounceable pseudowords differed only in terms of the presence or absence of one vowel and that, presumably, the unpronounceable pseudowords could not be recoded phonologically and kept in working memory as a phonological string. The difference between

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

spelling performance on legitimate and illegitimate letter strings of the Chinese children was significantly smaller than that of the L1 children. This result was true even after controlling for children's nonverbal ability, which suggests that the better performance by the Chinese ESL children in this spelling task could not be explained by their high nonverbal skills. Instead, this finding can be explained in two other ways. First, the English-speaking children had a negative transfer from their L1 reading and spelling experience. When the item presented could not be recoded phonologically, their spelling performance was severely impaired. However, this did not affect Chinese children as much as it did English L1 children. Second, the Chinese children seem to have used their visual–orthographic memory of a letter string "ensemble" better than the English L1 children. This result can be interpreted as a positive transfer effect from their Chinese reading experience. This interpretation is supported by Haynes and Carr's (1990) results with Chinese adult ESL readers in a visual matching task, as well as Koda's (1987, 1989) results with Japanese ESL adults in a recall task. These studies suggested that logographic readers (i.e., Chinese or Japanese) can draw on their visual–orthographic skills when phonological recoding of a word is impossible. It is noteworthy that in the present study these findings are replicated with young ESL children, whose Chinese reading experience is much more limited than that of adult ESL readers. As we noted earlier, these children had been exposed to part-time Chinese reading and writing in a rich language environment. These Chinese children, just like Chinese adult readers, appear to employ visually based coding strategies from their L1 reading and writing. This experience enables them to spell even when phonological information is minimal. It also enables them to visually identify correct spelling with more accuracy in an array than the English L1 children. It seems that these young Chinese L1 children can transfer their well-developed visual processing skills to L2 spelling.

There is some evidence in the literature suggesting that visual skills may play a particularly important role in learning to read Chinese for Hong Kong children, whose Chinese learning experience involves a whole-word strategy (e.g., Ho & Bryant, 1997c; Hoosain, 1991; Huang & Hanley, 1994). However, a few recent studies (e.g., Hu & Catts, 1998) did not find this relationship between visual skills and learning to read Chinese in other groups of Chinese children, such as children in Taiwan. In our study, Cantonese ESL children performed much better with visual presentation than auditory presentation of identical pseudowords. This result suggests that these Chinese ESL children may rely more on visual, holistic information and extract orthographic patterns for use in spelling, rather than utilizing a phonological strategy, a route that may be preferred by alphabetic L1 children. This preference by Chinese children is also reflected in the results of the confrontation spelling task, where they outperformed L1 children in spelling unpronounceable, visually presented pseudowords. On the whole, these results suggest that visual processing skill may be not only important in learning to read and write Chinese, as shown by others, but may also be applied by children learning to read and write in an alphabetic L2. This may constitute a possible compensatory strategy.

Although the Chinese L1 transfer interpretation may be a plausible framework for understanding the differences in spelling performance observed between

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Chinese and English L1 children, two caveats should be noted. First, Chinese children's poor performance in pseudoword spelling might be due to the fact that these children began their exposure to English later than English L1 children; indeed, the PPVT test indicated that these children had poor English vocabulary scores. Therefore, these children were probably slow to master sound–letter mapping rules in English and may have required more time to catch up with their English L1 counterparts. Their limited English learning experience may be just as important as the negative transfer from their Chinese learning experience in accounting for their difficulty in associating individual phonemes to graphemes in spelling unknown pseudowords. The results of the confrontation spelling task demonstrated that Chinese children performed significantly better on the illegitimate unpronounceable letter strings. There are three plausible interpretations for this finding. First, the Chinese ESL children applied their L1 visual memory strategies in L2 spelling, resulting in a positive transfer effect from Chinese L1. Second, the Chinese children may also have attempted to adopt the letter-naming strategy to spell the unpronounceable letter strings. Third, a negative transfer from English L1 might be responsible for poor performance in English L1 children. When phonological information is inaccessible for the orthographically illegitimate letter strings and these strings become unpronounceable, English-speaking children lose critical decoding information necessary for accessing lexical information, thus leading to difficulty in producing or retrieving these items. In order to test the L1 transfer effects more directly, future research should control for these confounding factors. One way to achieve this goal is to select a comparable ESL group with an alphabetic L1, for instance, Spanish-speaking ESL children, to contrast performance on the relevant measures. Such a comparison would allow researchers to match their English L2 proficiency level while testing the effect of differences among L1s on L2 spelling performance.

Second, due to demographic trends, the two language groups in this study came from different areas in Toronto. It is likely that the children in the two groups came from families with different socioeconomic status (SES). Future research should attempt to disentangle this possible confound of SES and linguistic background. In spite of these caveats, we still suggest that the performance differences found in this study are due to transfer of processing strategies from a logographic L1 orthography to an alphabetic L2 orthography. The resulting L1 transfer produces a positive effect on visual–orthographic processing and a negative effect on phoneme–grapheme mapping in L2 spelling, yielding different processing patterns for Chinese and English L1 children. When Chinese children can access their visual–orthographic memory of spelling patterns, they will use it to their advantage and outperform English L1 children who rely on decoding strategies. Conversely, when they are forced to access orthography through phonology, a less developed route, Chinese ESL children show great difficulty compared to the English L1 children. These results may in turn suggest that reading and spelling can be acquired through multiple routes.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

APPENDIX A

DEVELOPMENTAL SPELLING TASK

1.	CATS	These cats are black.	CATS
2.	WAS	The girl was sick.	WAS
3.	DOGS	The dogs bark.	DOGS
4.	VERY	He is very hungry.	VERY
5.	SAY	Can the man say anything?	SAY
6.	HAPPY	He is happy today.	HAPPY
7.	SHIP	The ship is in the water.	SHIP
8.	FIND	Did she find the ring?	FIND
9.	THEN	The boy came in and then sat down.	THEN
10.	STICK	The dog likes to play with a stick.	STICK
11.	TEETH	Your teeth are white.	TEETH
12.	PLEASE	She always says please.	PLEASE
13.	WANTED	I wanted to see a movie.	WANTED
14.	FLYING	The bird is flying in the sky.	FLYING
15.	THICK	The book is thick.	THICK
16.	PEEKED	She peeked under the door.	PEEKED

APPENDIX B

PSEUDOWORD SPELLING TASK

1.	SPIV	/spɪv/
2.	NESH	/nɛʃ/
3.	POTH	/pɑθ/ (/θ/ like in both)
4.	VIST	/vɪst/
5.	THOP	/θɑp/ (/θ/ like in through)
6.	SHEN	/ʃɛn/
7.	VESP	/vɛsp/
8.	STIV	/stɪv/
9.	THEG	/θɛg/ (/θ/ like in through)
10.	STUV	/stʌv/
11.	BESH	/bɛʃ/
12.	VUST	/vʌst/
13.	SHEB	/ʃɛb/
14.	VISP	/vɪsp/
15.	SPEV	/spɛv/
16.	GETH	/gɛθ/ (/θ/ like in both)

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

APPENDIX C

CONFRONTATION PSEUDOWORD SPELLING TASK

1. PCTH
2. NESH
3. POTH
4. STKV
5. VIST
6. THCP
7. SHEN
8. THOP
9. NFSH
10. STIV
11. SHFN
12. VKST

ACKNOWLEDGMENTS

The research reported here was funded by a Social Sciences and Humanities Research Council of Canada (SSHRC) grant to the second author and was based on part of Min Wang's Ph.D. dissertation at the University of Toronto. Preparation of the manuscript was supported by a postdoctoral fellowship funded by SSHRC to the first author. We would like to thank the former Editor, Catherine Snow, and two anonymous reviewers for their extremely helpful comments on an earlier version of this paper. Special thanks also go to Keiko Koda, Charles A. Perfetti, and Donald J. Bolger for their suggestions in the process of revising this paper.

REFERENCES

Akamatsu, N. (1999). The effects of first language orthographic features on word recognition processing in English as a second language. *Reading and Writing: An Interdisciplinary Journal, 11,* 381–403.

Baron, J. (1979). Orthographic and word specific mechanisms in children's reading of words. *Child Development, 50,* 60–72.

Besner, D., & Smith, M. C. (1992). Basic processes in reading: Is the orthographic depth hypothesis sinking? In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology and meaning* (pp. 192–210). Amsterdam: Elsevier Science.

Brown, T., & Haynes, M. (1985). Literacy background and reading development in a second language. In H. Carr (Ed.), *The development of reading skills* (pp. 19–34). San Francisco, CA: Jossey–Bass.

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition, 47,* 149–180.

Castles, A., & Coltheart, M. (1996). Cognitive correlates of developmental surface dyslexia: A single case study. *Cognitive Neuropsychology, 13,* 25–50.

Castles, A., Holmes, V. M., & Wong, M. (1997). Variations in spelling style among lexical and sublexical readers. *Journal of Experimental Child Psychology, 64,* 98–118.

Chan, J. W. C., & Vernon, P. E. (1988). Individual differences among the peoples of China. In

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

S. H. Irvine & J. W. Berry (Eds.), *Human abilities in cultural context.* Cambridge: Cambridge University Press.

Chen, H. C. (1992). Lexical processing in bilingual or multilingual speakers. In R. J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 283–298). Amsterdam: North–Holland.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of information processing* (pp. 151–216). New York: Academic Press.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological Review, 100,* 589–608.

Coltheart, M., Masterson, J., Byng, S., Prior, M., & Riddoch, J. (1985). Surface dyslexia. *Quarterly Journal of Experimental Psychology, 37A,* 469–495.

Cossu, G., Shankweiler, D., Liberman, I. Y., Tola, G., & Katz, L. (1988). Awareness of phonological segments and reading ability in Italian children. *Applied Psycholinguistics, 9,* 1–16.

Court, J. H. (1991). Asian applications of Raven's Progressive Matrices. *Psychologia, 34,* 75–85.

DeFrancis, J. (1989). *Visible speech: The diverse oneness of writing system.* Honolulu: University of Hawaii.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary Test–III.* Circle Pines, MN: American Guidance Service.

Durgunoglu, A. Y., & Oney, B. (1999). A cross-linguistic comparison of phonological awareness and word recognition. *Reading and Writing: An Interdisciplinary Journal, 11,* 281–299.

Feldman, L. B. (1987). Phonological and morphological analysis by skilled readers of Serbo–Croatian. In A. Allport, D. G. MacKay, W. Prinz, & G. Scheerer (Eds.), *Language perception and production* (pp. 197–210). London: Academic Press.

Frith, U., Wimmer, H., & Landerl, K. (1998). Differences in phonological recoding in German- and English-speaking children. *Scientific Studies of Reading, 2,* 31–54.

Frost, R. (1994). Prelexical and postlexical strategies in reading: Evidence from a deep and shallow orthography. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 116–129.

Frost, R., & Bentin, S. (1992). Reading consonants and guessing vowels: Visual word recognition in Hebrew orthography. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 27–44). Amsterdam: Elsevier Science.

Geva, E. (1995). Orthographic and cognitive processing in learning to read English and Hebrew. In I. Taylor & D. R. Olson (Eds.), *Scripts and literacy: Reading and learning to read alphabets, syllabaries, and characters* (pp. 277–291). Dordrecht: Kluwer.

Geva, E., & Siegel, L. (2000). Orthographic and cognitive factors in the concurrent development of basic reading skills in two languages. *Reading and Writing: An Interdisciplinary Journal, 12,* 1–30.

Geva, E., Wade–Woolley, L., & Shany, M. (1993). The concurrent development of spelling and decoding in two different orthographies. *Journal of Reading Behavior, 25,* 383–406.

Geva, E., Yaghoub–Zadeh, Z., & Schuster, B. (2000). Understanding individual differences in word recognition skills of ESL children. *Annals of Dyslexia, 50,* 123–154.

Goswami, U., Gombert, J., & Barrera, L. (1998). Children's orthographic representations and linguistic transparency: Nonsense word reading in English, French, and Spanish. *Applied Psycholinguistics, 19,* 19–52.

Hanley, J. R., Tzeng, O., & Huang, H.-S. (1999). Learning to read Chinese. In M. Harris & G. Hatano (Eds.), *Learning to read and write: A cross-linguistic perspective* (pp. 173–195). Cambridge: Cambridge University Press.

Haynes, M., & Carr, T. H. (1990). Writing system background and second language reading: A component skills analysis of English reading by native speakers-readers of Chinese. In T. H. Carr & B. A. Levy (Eds.), *Reading and its development: Component skills approaches* (pp. 375–421). Toronto: Academic Press.

Henderson, L. (1982). *Orthography and word recognition in reading.* London: Academic Press.

Ho, C. S.-H., & Bryant, P. (1997a). Development of phonological awareness of Chinese children in Hong Kong. *Journal of Psycholinguistic Research, 26,* 109–126.

Ho, C. S.-H., & Bryant, P. (1997b). Learning to read Chinese beyond the logographic phase. *Reading Research Quarterly, 32,* 276–289.

Ho, C. S.-H., & Bryant, P. (1997c). Phonological skills are important in learning to read Chinese. *Developmental Psychology, 33,* 946–951.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Holm, A., & Dodd, B. (1996). The effect of first written language on the acquisition of English literacy. *Cognition, 59,* 119–147.

Holm, A., & Dodd, B. (1999). A longitudinal study of the phonological development of two Cantanese–English bilingual children. *Applied Psycholinguistics, 20,* 349–376.

Hoosain, R. (1991). *Psycholinguistic implications for linguistic relativity: A case study of Chinese.* Hillside, NJ: Erlbaum.

Hu, C.-F., & Catts, H. W. (1993). Phonological recoding as a universal process? Evidence from beginning readers of Chinese. *Reading and Writing: An Interdisciplinary Journal, 5,* 325–337.

Hu, C.-F., & Catts, H. W. (1998). The role of phonological processing in early reading ability: What we can learn from Chinese. *Scientific Studies of Reading, 2,* 55–79.

Huang, H., & Hanley, R. (1994). Phonological awareness and visual skills in learning to read Chinese and English. *Cognition, 54,* 73–98.

Huang, H., & Hanley, R. (1997). A longitudinal study of phonological awareness, visual skills and Chinese reading acquisition among first-graders in Taiwan. *International Journal of Behavioral Development, 20,* 249–268.

International Phonetic Association. (1996). Reproduction of the International Phonetic Alphabetic. Retrieved from http://www2.arts.gla.ac.uk/IPA/ipachart.html

Jackson, N. E., Chen, H-W., Goldsberry–Shaver, L., Kim, A., & Vanderwerff, C. (1999). Effects of variations in orthographic information on Asian and American readers. *Reading and Writing: An Interdisciplinary Journal, 11,* 345–379.

Jackson, N. E., Lu, W-H., & Ju, D. (1994). Reading Chinese and reading English: Similarities, differences and second-language reading. In V. W. Berninger (Ed.), *The varieties of orthographic knowledge. I: Theoretical and developmental issues* (pp. 73–109). Dordrecht: Kluwer.

Johnson, J. S., & Newport, E. L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology, 21,* 60–99.

Ju, D., & Jackson, N. E. (1995). Graphic and phonological processing in Chinese character identification. *Journal of Reading Behavior, 27,* 299–313.

Katz, L., & Frost, R. (1992). The reading process is different for different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology and meaning* (pp. 67–84). Amsterdam: Elsevier Science.

Koda, K. (1987). Cognitive strategies transfer in second language reading. In J. Devine, P. L. Carrell, & D. E. Eskey (Eds.), *Reading in English as a second language* (pp. 127–144). Washington, DC: TESOL.

Koda, K. (1989). Effects of L1 orthographic representation on L2 phonological coding strategies. *Journal of Psychological Research, 18,* 201–222.

Koda, K. (1994). Second language reading research: Problems and possibilities. *Applied Psycholinguistics, 15,* 1–28.

Koda, K. (1999). Developing of L2 intraword orthographic sensitivity and decoding skills. *The Modern Language Journal, 83,* 51–64.

Koda, K. (2000). Cross-linguistic variations in L2 morphological awareness. *Applied Psycholinguistics, 21,* 297–320.

Lam, M. (1999). *The development of phonological awareness in Chinese ESL children.* Unpublished Master's thesis, University of Toronto.

Leck, K. J., Weekes, B. S., & Chen, M. J. (1995). Visual and phonological pathways to the lexicon: Evidence from Chinese readers. *Memory and Cognition, 23,* 468–476.

Leong, C. K. (1997). Paradigmatic analysis of Chinese word reading: Research findings and classroom practices. In C. K. Leong & R. M. Joshi (Eds.), *Cross-language studies of learning to read and spell: Phonological and orthographic processing* (pp. 378–417). Dordrecht: Kluwer Academic.

Leong, C. K., & Tamaoka, K. (Eds.). (1998). Cognitive processing of the Chinese and the Japanese languages [Special volume]. *Reading and Writing: An Interdisciplinary Journal, 10.*

Li, C. N., & Thompson, S. A. (1981). *Mandarin Chinese: A functional reference grammar.* Los Angeles: University of California Press.

Markwardt, F. C. (1989). *Peabody Individual Achievement Test–Revised.* Circle Pines, MN: American Guidance Service.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press

Mattingly, I. G. (1987). Morphological structure and segmental awareness. *Cahiers de Psychologie/ Current Psychology of Cognition, 7,* 488–493.
Mattingly, I. G. (1992). Linguistic awareness and orthographic form. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 11–26). Amsterdam: Elsevier Science.
McBride–Chang, C., & Ho, C. S.-H. (2000). Developmental issues in Chinese children's character acquisition. *Journal of Educational Psychology, 92,* 50–55.
Naglieri, J. (1985). *Matrix Analogies Test: Expanded Form*. San Antonio, TX: Psychological Corporation/Harcourt Brace Jovanovich.
Perfetti, C., Liu, Y., & Tan, L.-H. (2000). *The lexical constituency model: Some implications of research on Chinese for general theories of reading.* Manuscript submitted for publication.
Perfetti, C. A., & Tan, L. H. (1998). The time course of graphic, phonological, and semantic activation in visual Chinese character identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24,* 101–118.
Perfetti, C. A., & Tan, L. H. (1999). The constituency model of Chinese word recognition. In J. Wang, A. W. Inhoff, & H.-C. Chen (Eds.), *Reading Chinese script: A cognitive analysis* (pp. 115–134). Mahwah, NJ: Erlbaum.
Perfetti, C. A., & Zhang, S. (1991). Phonological processes in reading Chinese characters. *Journal of Experimental Psychology, 17,* 633–643.
Perfetti, C. A., & Zhang, S. (1995). Very early phonological activation in Chinese reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 24–33.
Rack, J., Snowling, M., & Olson, R. (1992). The nonword reading deficit on developmental dyslexia. *Reading Research Quarterly, 27,* 29–53.
Read, C., Zhang, Y.-F., Nie, H.-Y., & Ding, B.-Q. (1986). The ability to manipulate speech sounds depends on knowing alphabetic writing. *Cognition, 24,* 31–44.
Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review, 96,* 523–568.
Shimron, J. (1993). The role of vowels in reading: A review of studies in English and Hebrew. *Psychological Bulletin, 114,* 52–67.
Shimron, J. (1999). The role of vowel signs in Hebrew: Beyond word recognition. *Reading and Writing: An Interdisciplinary Journal, 11,* 301–319.
Shu, H., & Anderson, R. C. (1997). Role of radical awareness in the character and word acquisition of Chinese children. *Reading Research Quarterly, 32,* 78–89.
Shu, H., Anderson, R. C., & Wu, N. N. (2000). Phonetic awareness: Knowledge of orthography–phonology relationships in the character acquisition of Chinese children. *Journal of Educational Psychology, 92,* 56–62.
Tan, L.-H., & Perfetti, C. (1998). Phonological codes as early sources of constraint in Chinese word identification: A review of current discoveries and theoretical accounts. *Reading and Writing: An Interdisciplinary Journal, 10,* 105–200.
Taylor, I., & Taylor, M. M. (1983). *The psychology of reading.* New York: Academic Press.
Treiman, R. (1993). *Beginning to spell.* New York: Oxford University Press.
Tzeng, O. J. L., & Wang, W. S. Y. (1983). The first two R's. *American Scientist, 71,* 238–243.
Verhoeven, L. (1990). Acquisition of reading in Dutch as a second language. *Reading Research Quarterly, 25,* 90–114.
Wade–Woolley, L. (1999). First language influences on second language word reading: All roads lead to Rome. *Language Learning, 49,* 447–471.
Wade–Woolley, L., & Siegel, L. S. (1997). The spelling performance of ESL and native speakers of English as a function of reading skills. *Reading and Writing: An Interdisciplinary Journal, 9,* 387–406.
Wang, M., & Geva, E. (in press). Spelling acquisition of novel English phonemes in Chinese children. *Reading and Writing: An Interdisciplinary Journal*.
Weekes, B. S., Chen, M. J., & Lin, Y.-B. (1998). Differential effects of phonological priming on Chinese character recognition. *Reading and Writing: An Interdisciplinary Journal, 10,* 201–222.
Wimmer, H., Mayringer, H., & Landerl, K. (2000). The double-deficit hypothesis and difficulties in learning to read a regular orthography. *Journal of Educational Psychology, 92,* 668–680.

https://doi.org/10.1017/S0142716403000018 Published online by Cambridge University Press