THE DEVELOPMENT OF SPELLING AND ITS RELATIONSHIP TO DECODING AND PHONOLOGICAL PROCESSING IN CHINESE ESL CHILDREN

By

Min Wang

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
Department of Human Development and Applied Psychology
Ontario Institute for Studies in Education of the University of Toronto

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The Development of Spelling and Its Relationship to Decoding and Phonological Processing in Chinese ESL Children

Doctor of Philosophy (2000)

Min Wang

Dept. of Human Development and Applied Psychology
Ontario Institute for Studies in Education
University of Toronto

ABSTRACT

The purpose of the present study was to explore the development of spelling of young Chinese ESL children over a two-year period, and to compare their development to that of a control group of native English speaking (L1) children. The effects of L1-specific phonemes, the effects of lexicality and visual-orthographic processing on ESL acquisition were examined. The relationships between spelling, reading, and phonological processing were explored.

The results from developmental trend analyses suggested a similar developmental trajectory of spelling levels across time for L1 and ESL children. Inaccurate spellings in Chinese ESL children reflected difficulty in spelling certain phonemes that are absent in L1 phonology. However, this negative transfer did not persist across time. Chinese ESL children showed poorer performance in spelling pseudowords than real words, but outperformed L1 children in a confrontation spelling task, and performed better in spelling the pseudowords presented visually than when they were presented orally.

Correlational analyses showed that both L1 and ESL children's spelling performance was significantly correlated with reading measures. Phoneme
deletion, a measure of phonological awareness, was found to correlate significantly with the spelling task for both groups, but phonological working memory correlated significantly with the spelling in ESL but not for L1 children. Regression analyses revealed that reading measures accounted for a significant amount of the variance in predicting performance on the spelling task for both L1 and ESL children. Phonological measures accounted for a significant amount of the variance in predicting spelling performance for both L1 and ESL when entered before reading scores, but became non-significant when entered after reading scores.

The above results provide insight into the interaction between universal and language-specific processes of learning to read and write in L2. These results suggest that the language-specific model better applies to early stages of L2 acquisition, and better predicts children’s acquisition of L1-specific structures of L2, whereas the universal model best predicts the general order of difficulty and underlying cognitive processes in the development of spelling of English words. During the course of L2 development, the language transfer effect gradually decreases, while universal processes increase.
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CHAPTER 1: INTRODUCTION

There has long been well-established research in the area of reading and spelling for English as first language (L1) learners. Different systematic theories or models have been developed to explain the processes of reading and spelling development (e.g., Adams, 1990; Ehri, 1991, 1992, 1993; Gough, et al., 1991, 1992; Read, 1986a; Treiman, 1993). However, compared to the vast volume of literature on English as L1 reading, a comprehensive theory of second language (L2) learning is absent (e.g., Geva, 1995; 1999; Geva & Siegel, 2000). In recent decades, one of the major controversies in L2 learning has been the role played by the L1 in developing various L2 skills. For example, there was a tendency among some researchers to assume that L2 reading development is driven by similar or identical underlying component processes to L1 reading, and therefore, that theoretical frameworks for L1 can be applied directly to L2 reading research (e.g., Mclaughlin, 1978). Cross-language transfer studies focusing on linguistic interdependence across language systems also showed evidence that many aspects of reading and writing skills are interdependent and transferable across languages (e.g., Hakuta, 1986; Carlo & Royer, 1994; Durgunoğlu, Nagy and Hancin-Bhatt, 1993; Cisero & Royer, 1995; Comeau, Cormier, Grandmaison, & Lacroix, 1999). However, some researchers point to the importance of taking language differences into account when studying reading development. For example, language systems differ in terms of phonological features as well as orthographic, lexical and morphosyntactic complexity. These researchers maintain that the processes of learning to read in a
first language may differ in some ways from the processes of learning to read in a second language, and that L1 plays an important role in L2 learning (e.g., Verhoeven, 1990; Harris, 1992; Haynes & Carr, 1990; Koda, 1987, 1989, 1994, 1999; Akamatsu, 1999; Wade-Woolley & Geva, 2000).

The relationship between phonological processing and reading and spelling in both L1 normally-achieving and poor readers and spellers has been the object of extensive research over the past two decades. Phonological processing has been proven to be a crucial underlying component in various processes such as recoding in working memory, accessing the lexicon, and reading novel words (Wagner & Torgesen, 1987; Stanovich, 1986; Goswami & Bryant, 1990; Rack, Snowling, & Olson, 1992; Torgesen, 1999; Shankweiler, 1999). It has also been shown to be a robust predictor of reading and spelling development in young L1 children. However, compared to the large volume of literature on the role of phonological processing in reading and spelling in L1, not enough is known about its role in L2 reading and spelling.

Chinese represents a unique writing system among the languages in the world (Aaronson & Ferres, 1987; Hoosain, 1991; Leong & Tamaoko, 1998; see Hanley, Tzeng & Huang, 1999 for a recent review). Unlike alphabetic writing systems such as English, French, Spanish or Punjabi, a Chinese character represents a monosyllabic morpheme and has no subsyllabic code for matching a word’s component orthographic elements with a sequence of phonemes. Chinese readers could find it difficult to acquire the phonological parsing skills necessary for
reading an alphabetic language such as English. Chinese is also a morphologically "flat", or uninflected language, that is, it has no syntactical markers for tense or pluralization, and does not employ articles and auxiliaries (see Kao & Hoosain, 1986; Sampton, 1985; Chen & Tzong, 1992 for a review). Chinese phonology does not include certain phonemes such as /th/, and /sh/ as well as consonant clusters such as /st/ (Chao, 1947; Wong, 1954; Hashimoto, 1972, Holm & Dodd, 1999; Leong, personal communication). Therefore, Chinese ESL readers may have more difficulty in learning to read and spell words which include phonological elements absent from their L1.

Hence, Chinese ESL readers present a unique opportunity for probing the role of contrastive properties of L1 in the process of learning to read L2. Most of the studies in the literature to date have been concerned with comparing Chinese ESL adults with English as L1 adults (Haynes & Carr, 1990; Holm & Dodd, 1996; Jackson, Lu, & Ju, 1994; Jackson, Chen, Goldsberry-Shaver, Kim, & Vanderwerff, 1999; Koda, 1998). Few studies have been conducted with respect to ESL learning by young Chinese children at their critical language acquisition period. Furthermore, a very limited number of longitudinal studies have been carried out on L2 learning. The purpose of the present study was to explore the development of spelling of young ESL Chinese children over a two-year period, and to compare their development to that of a control group of native English speaking children. The effects of L1-specific features in ESL acquisition was examined. The
relationship between spelling, reading and phonological processing was explored as well.

It was hoped that the present study would extend our knowledge of ESL learning in general and the development of reading and spelling in particular. It would contribute to the debate between the universal and language-specific perspectives in learning to read and spell in L2. A complementary model of the two frameworks would be supported by research evidence for the role of a contrastive L1 in L2 acquisition and similar trajectories in the developing reading and spelling skills across time. Furthermore, the research would also help to unravel, to a certain extent, the different role that L1 plays during different stages of L2 learning, and in the learning of contrastive phonological and orthographic units, which most previous studies have failed to identify.

The present study has also practical and educational implications. According to Statistics Canada (TIME, May, 1999), by 2005, 16% of the national population will have a mother tongue other than English or French. In some metropolitan areas like Toronto this figure is significantly higher at present, and will reach 54% by 2000. Among these immigrants, the number of Chinese population will reach approximately 1.2 million nationwide by 2001. Facing this dramatic change in the nation’s “tapestry”, there is a growing concern about the educational system’s ability to meet the needs of the increasingly diverse multi-ethnic classroom. One crucial concern among these needs is the acquisition of fluent reading and writing skills. It was hoped that the present study would help
us gain a better understanding of the correlates and precursors of ESL reading and writing development. It would be also a useful source of information to teachers and parents about specific linguistic units which would be more challenging to children with given L1 backgrounds and the rate at which these units are mastered by normal achieving ESL children (Geva, 1999). More specifically, the research would provide some suggestions for helping Chinese-speaking children to acquire English literacy in an English-speaking environment.

The thesis is organized into the following chapters. Chapter 2 provides a review of the relevant literature. It begins with an overview of reading and spelling development in English-as-L1 children. Second, the Chinese writing system and its phonology are introduced and the controversial role of phonological processing in Chinese reading is discussed. Third, some important issues in the field of second language acquisition are considered, such as the effect of critical period, theoretical frameworks in second language acquisition including Contrastive Analysis Hypothesis, Markedness Differential Hypothesis, Orthographic Depth Hypothesis, and the Central Processing Hypothesis. Fourth, the chapter reviews the previous research on Chinese ESL adult readers, focusing on the transfer effects of L1 (Chinese) on phonological and orthographic performance in L2 (English). The chapter concludes with a discussion of recent research on L2 children’s spelling performance, the topic of the thesis.

Chapter 3 introduces the methodology used in the present study. Chapter 4 and Chapter 5 present the results of the study. In Chapter 4, the effects of language
and time on children's performance on various spelling tasks are examined and the spelling error patterns on the digraphs /sh/ and /th/ are analyzed in detail. In Chapter 5, the results exploring the relationship between spelling, reading, and phonological processing in L1 and ESL children are presented.

In Chapter 6 a general discussion of the results is provided from theoretical and educational perspectives. Limitations and suggestions for future research are presented as well.
CHAPTER 2: LITERATURE REVIEW

Reading and Spelling Development in L1 Children

There seems to be convergence among researchers concerning the developmental stages of early reading and spelling skills by young children learning to read English as their L1. According to Gough and his colleagues (Gough, Juel, & Roper/Schneider, 1983; Gough, Juel, 1991; Gough, Juel, & Griffith, 1992), beginning readers pass through two stages in their use of graphic cues to read words. Children in the first stage are called cue readers, and in the second stage are cipher readers. During the first stage, the mechanism of selective associated learning is used to read words. With the acquisition of the orthographic cipher (knowledge of the letter-sound correspondences), children increase their ability to recognize words. The distinction between children who do and do not know the cipher predicts a number of differences in the way they read and it also predicts differences in the way they spell. Stanovich (1986b) showed that children who mastered the cipher in the first grade will be successful readers by the time they reach the fourth grade, whereas those who have not mastered the cipher remain poor readers three years later.

Ehri and Wilce (1987, see also Ehri, 1992; 1993), however, argued for an intermediate phase between visual-cue reading and cipher reading proposed by Gough, et al. (1992) to describe how children read words. In this phonetic-cue reading stage, children use partial letter-sound cues to remember how to read
words. Their research findings indicated that phonetic-cue reading replaces visual-cue reading at a very early point in acquisition. Those visual-cue readers labeled in Gough and Ehri’s reading models are often called “Chinese” readers (Baron & Strawson, 1976), after the readers skilled with a logography, an orthography assumed to lack an alphabetic cipher. However, this view of “Chinese” as visual-cue readers has been challenged by recent research, which we will discuss in another section in this review.

Treiman and her colleagues’ work on the internal structure of the syllable contributes a great deal to reading and spelling development, especially to a better explanation of the phonological development in reading and spelling acquisition. According to Treiman (e.g., 1983; 1985; 1988; 1991; 1992, 1993), syllables, onsets and rimes constitute units of linguistic processing that are more accessible than the phoneme. In a series of studies (e.g., Treiman & Baron, 1981; Treiman & Danis, 1988; Treiman, Fowler, Gross, Berch, & Weatherston, 1995; Treiman, Mullennix, Bijeljac-Babic, Richmond-Welty, 1995; Kessler & Treiman, 1997; Steffler, Varnhagen, Friesen, & Treiman, 1998), Treiman and her colleagues demonstrated the developmental priority of onsets and rimes, suggesting that this initial segmentation may serve as a guide for researchers in focusing explicit attention on the internal structure of the syllable.

Fowler (1990; 1991) supported Teiman’s efforts and further argued that very young children with a small vocabulary store the phonological representations of lexical items at a holistic level and the phonemic segmental organization emerges
only gradually in early childhood. Her view has challenged the traditional notion of phonemic awareness as part of children’s “natural endowment” for language (see Shankweiler, 1999, for a review). Instead, according to Fowler, the phonemic organization of the word is not a given but the result of a developmental process that undergoes fundamental phonological representations changes throughout childhood. Fowler’s suggestion may have a significant implication for second language learning. The fundamental developmental processes in organizing phonological representations may be more prominent when learning to read and write a second language, especially when there exist differences between the two language systems. For instance, Chinese ESL children may lack in their phonological inventory certain phonemes represented in L2, and consequently have nothing in their speech to attach to the visual signs. This may interfere with learning both to read and more importantly to spell. In other words, as Chinese ESL children acquire a novel phoneme in a second language, they are required to reconstruct the original phonological input at various levels, such as speech perception, oral production, and grapheme representation in reading and spelling.

**Relationships between Reading and Spelling in L1 Children.**

How are spelling and reading related to one another? According to many researchers, the relationship is very close in English as L1 (Ehri, 1986; Ehri & Robbins, 1992; Gough, Juel, & Griffith). Children who are good readers are usually good spellers. Ehri (1986) found that when first graders are taught to read a set of
words, their spelling of these words improves even if they do not practice writing the words. Ehri and Robbins (1992) provided further evidence that information remembered from reading words affects children's spelling. On the other hand, according to Ehri and Wilce (1979), spellings have mnemonic power which helps readers remember the phonological forms of words when they symbolize the words phonemically. Thus, they argue that spelling and reading draw on a similar fund of knowledge.

However, according to other researchers, reading and spelling are not all that closely related. Some children and adults read well but spell badly. Frith (1980) studied the spelling and reading processes of 'unexpectedly poor spellers'. She showed that the good readers-poor spellers probably read by 'partial cues'. Frith argues that they did not typically attend to the spelling of the words they read, but relied more heavily on context, shape and some of the letters in a target word. Bryant and Bradley (1980), Bradley and Bryant (1985) suggested as well that spelling and reading are especially disconnected for young children especially at an early stage of reading. They found that normal children of six and seven sometimes spell words like 'bun' and 'mat' correctly but cannot read them. They suggested that children at an early stage use different strategies in reading and spelling, and that young children employ a visual strategy when they read and a phonological strategy when they spell. Gough et al. (1992), however, questioned this different-strategy view and argued that both skilled reading and skilled spelling are based upon the cipher. They agree, however, that in spite of a high
degree of consistency between spelling and reading, which can be attributed to
their common basis (i.e., the cipher), spelling cannot be seen as simply a reflection
of reading.

**Relationships between Phonological Processing and Reading and Spelling in L1 Children.**

It is generally acknowledged that phonology plays an important role in
reading and spelling. Evidence to support this comes from some early studies
showing that young children have difficulty analyzing speech into phonemes and
that phonemic awareness is strongly correlated with beginning reading ability
(e.g., Liberman, Shankweiler, Fischer, & Carter, 1974; Lundberg, Olofsson, & Wall,
1980; Bradly & Bryant, 1983).

Liberman, et al. (1974) examined the ability of 4-, 5-, and 6-year-olds to
segment words by phonemes and syllables. They found that none of the 4-year-
olds could segment by phonemes, but half could segment by syllable. Only 17% of
the 5-year olds could segment by phoneme, and again half could segment by
syllable. By age 6, 70% could segment by phoneme and 90% by syllable. Early
support for the relationship between phonological awareness and later success at
reading and spelling came from a large-scale longitudinal study carried out in
Sweden with children in Kindergarten and grade one (Lundberg, Olofsson, & Wall,
1980). Children were tested on a number of measures of phonological awareness in
kindergarten and reading and spelling measures in grade one. The phonological
measures requiring analysis of phonemes were more strongly predictive of reading
skills than were those that required analysis of syllables. This relationship was found reliable for several years.

More evidence from Read (1986a) and Treiman (1993) demonstrates a heavy reliance on phonology in children’s invented spellings and phonologically accurate misspellings in older children. As well, research reveals that phonological awareness measures tend to be highly correlated with spelling ability (Bruck & Treiman, 1990; Griffith, 1991). Goswami and Bryant (1990) noted that in children’s spelling there is “no sign of a global strategy, or of a logographic stage” (p. 61).

However, there has been a controversy as to the causal nature of the relation between phonological awareness and learning to read and spell. Researchers like Ehri (see Ehri, 1998, for a review) argue that children’s knowledge of the spellings of words influences their sound-segmentation ability. Children’s phonemic awareness is acquired when they learn how the alphabetic system works to represent speech phonemically. Vernon and Ferreiro (1999) also found in Spanish-speaking kindergartners that the children’s ability to segment words into phonemes depends on their overall knowledge of the writing system. Other researchers (Bertelson, de Gelder, Tfouni, & Morais, 1989; Blanche-Benveniste, 1994; Morais, Al egria, & Content, 1987; Read, Zhang, Nie, & Ding, 1986b; see Olson, 1996 for a review) also provide evidence that people who lack knowledge of alphabetic spellings such as nonliterate adults or readers of non-alphabetic orthographies have little awareness of or ability to manipulate phonemes in words (although this notion has been challenged by recent research led by C. Perfetti, see
a review in this chapter under the section "The role of phonological processing in Chinese reading"). Read, et al. (1986b) provide an argument for a strong connection between alphabetic literacy and phonemic awareness in a study comparing two groups of Chinese adults, one including individuals who had learned to read using the alphabetic form of Chinese (pinyin) and were literate in alphabetic spelling as well as characters, the other including individuals who were literate only in Chinese characters. They were tested for their phoneme deletion and addition abilities. They were asked to add or delete a single consonant at the beginning of a syllable. Results showed that the "alphabetic" group, including those who had once learned alphabetic writing but were no longer able to use it, succeeded in manipulating speech sounds while the nonalphabetic group experienced great difficulty. They claim that "it is not literacy in general which leads to segmentation skill, but alphabetic literacy in particular" (p. 41).

Huang and Hanley (1997) found similar effects in a longitudinal study that investigated phonemic awareness in Chinese children who, in addition to learning characters, were taught an alphabetic script. Chinese children in grade one were given a series of tasks that tested for phonemic awareness: once at the beginning of the school year; once 10 weeks later, after having been taught an alphabetic script; and again at the end of the school year, after having been taught to read and write Chinese characters. They found that there was a significant increase in phonological awareness after the children had learned the alphabetic script, but there was not a significant increase between Time 2 (after learning the alphabetic
script) and Time 3 (at the end of the school year, after learning characters). These findings led the authors to conclude that to some extent, phonemic awareness depends on learning an alphabetic script.

Similarly, Mann (1986) compared the phoneme and syllable manipulation skills of American and Japanese first-graders. She found that, while both groups found phoneme deletion more difficult than syllable deletion, the difference between performance on the syllable and phoneme conditions within each group were far greater among Japanese than American children. Mann concluded that the influence of reading a syllabary is reflected in the poor performance by Japanese children on phonemic deletion and their superior performance on syllable manipulation.

Spagnoletti, Morais, Alegia, and Dominicy (1989) replicated Mann’s study with two groups of Japanese first-graders in Brussels. Children in one of the groups learned to read a Roman alphabet, subsequent to the Japanese writing system, while those in the other group learned the Japanese scripts only. It was found that both groups performed better in the syllable than phoneme condition, and despite the differential alphabetic experience the groups did not differ in their performance on phoneme manipulation. Interestingly, post-study interviews revealed that both groups of Japanese children favored a syllabic-spelling strategy for phonemic tasks. Thus, the researchers argue that initial literacy experience in nonalphabetic scripts does not promote phonemic awareness to the same extent as alphabetic literacy.
In sum, to date, most researchers consider the issue of causal nature between phonological awareness and literacy acquisition settled at this point. The relation is thought to be reciprocal, with causation running in both directions: Phonemic awareness is a cause as well as a consequence of literacy acquisition. This reciprocity has important implication for second language research. If it is true that a high level of phonemic awareness derives from exposure to an alphabetic literacy, then we can assume that ESL readers with nonalphabetic L1 background will have a weak phonemic awareness, which in turn, will affect initial acquisition of L2 reading (see Koda, 1998 for a review).

Learning to Read and Write in Chinese

Chinese Characters and Phonology.

The Chinese people use a writing system that has been in operation for several thousand years. It differs in many important respects from the alphabetic writing systems. Unlike alphabetic writing systems such as English, French, Spanish or Punjabi, Chinese does not provide readers a subsyllabic code by which they can match a word's component orthographic elements with a sequence of phonemes. A unit of written Chinese is the character, and the distinctiveness of a character lies in its being simultaneously "a visual whole, a syllabic unit, and the unit of meaning" (Hoosain, 1991). A character’s appearance is often not predictably related to its pronunciation, so characters may be described as purely meaning based, or logographic.
However, because each character represents a single syllable, it is also labeled morpho-syllabic (DeFrancis, 1989; Jackson, et al., 1994; Leong, 1997) to emphasize the phonetic component of Chinese characters. Others label it as phonosemantic (Boodberg, 1937, cited in Leong, 1997) to stress the meaning part of the character. Furthermore, most Chinese characters (about 90%) contain phonetic components and semantic radicals that provide clues to some aspects of the pronunciation and meaning of the character (Hoosain, 1991). Take, for example, the character % which means ocean and is pronounced as yang (in Pinyin). The left part $ which is the semantic radical means water. The right part of the character % is the phonetic, which means goat and is pronounced as yang. Note that the radical and the phonetic are associated differently with the meaning and sound of a Chinese character. Some Chinese characters share the same semantic radical, but have different phonetic components. However, some Chinese characters share the same phonetic element, that is, they have the same pronunciation, but belong to different semantic categories (see Figure 1, adapted from Ho & Bryant, 1997a). In this figure, the first line lists the characters, the second line the pronunciations (based on Pinyin, an alphabetic script, used in learning to read the Chinese character), and the third line lists the meaning for each character. Part A lists the 3 characters which share the same semantic radical of % but have different phonetic components. Part B lists the 3 characters which have the same pronunciation, but have different meanings. Based on these analyses, some researchers argue that it is probably not accurate to refer to Chinese as a logographic writing system.
Nearly all characters in Chinese are monosyllabic. It is conventional to dissect a Chinese syllable into initial and final sound segments (i.e., the onset and rime). The initial segment represents the consonantal beginning of a syllable. However, there are no consonant clusters in Chinese syllables either before or after the vowel. As Wang (1973, cited in Huang & Hanley, 1994) noted: “One striking feature of Chinese words in comparison with most European words is the lack of clusters of consonants before and after the nuclear vowels. When European words with consonant clusters are represented in Chinese, they are typically broken up so that each consonant has its own syllable” (p. 57). This is the case for all Chinese languages, including Cantonese and Mandarin. For example, the name “Clinton” in Chinese is rendered with three characters representing three syllables: 克林顿 (ke lin don). Therefore, it would be obvious that the number of syllables is much smaller in Chinese than in English. In other words, it is much easier to represent spoken Chinese in the form of syllabic writing system than English. Many
thousands of different symbols would be necessary if English words were written syllabically.

The consequence of the small number of syllables in Chinese is that the number of morphemes that can be given a unique representation in spoken Chinese is relatively small. This means that many morphemes share the same syllable. In other words, there is relatively large number of homonyms in Chinese. This number is reduced somewhat by the existence of specific pitch patterns by which characters are spoken, known as tones (Leong, 1997; Ho & Bryant, 1997b). The features of the tones are not lined up in sequence with phonemes but are superimposed on them. In Chinese, tonal difference affects meaning just as change in consonants and vowels does. The number of tones in the Chinese language varies from one dialect to another. For instance, there are four tones in Mandarin (high-level, high-rising, falling-rising, and high falling), and nine tones in Cantonese, exploring the upper and lower registers more fully (Hoosain, 1991).

Chinese morphology also adds to the differences from other languages. There is very little morphological complexity in the Chinese language. Each character consists of just one morpheme and can not be further analyzed into component parts. Chinese words generally have no grammatical inflections to indicate case, number, gender, tense, or degree (Li & Thompson, 1981). For instance, the category of number is not a necessary one in Chinese, 牛 (niu) can refer to either "cow" or "cows" in Mandarin. If the concept of plurality needs to be expressed, it is typically expressed by a separate word such as 一些 (yi xie)
“some”, or 许多 (xu duo) “many”, and involves no morphological complexity within a word. Likewise, Chinese has no markers for tense, though it does have some morphemes to signal tenses, for example, 了 (le) “past action”, 着 (zhe) “duration action” in a different character. For example, “walked” is represented in Chinese as two characters 走了, while “walking” is represented in Chinese as two characters 走着.

**How Chinese Children Are Taught to Read Chinese.**

Chinese children are taught to read and write in a way which differs dramatically from one area of China to another. In Mainland China and Taiwan, children have been introduced to the reading of Mandarin via a quite separate alphabetic system since the 1950s (Tzeng, Hung, & Wang, 1977, see also Hanley, Tzeng & Huang, 1999). In mainland China all children in the first grade (six to seven years) are taught to read an alphabetic script (Pinyin) before beginning to read and write Chinese characters. Similarly, all children in Taiwan learn an alphabetic script known as Zhu-Yin-Fu-Hao during the first ten weeks of the first grade before any instruction in reading and writing Chinese characters is given (Tzeng, et al., 1977). In Hong Kong, Pinyin is not incorporated to teach reading in Cantonese, although a small number of primary schools employed Pinyin when the children are subsequently taught to read in Mandarin. The number of schools using Pinyin to teach reading may grow rapidly in the coming years following the
recent political change in Hong Kong (see Hanley, Tzeng & Huang, 1999 for a review).

In Hong Kong, children as young as three years old in their first kindergarten year are taught to read (see Ho & Bryant, 1997a, 1997b for a review). By the end of first grade they should be able to read 460 different characters, and by the end of second grade they should be able to read 960 different characters. Children in Hong Kong are generally taught by rote learning: they learn new characters by copying them many times and memorize them at the end. The teacher will provide the meaning and pronunciation of the character, but the children’s attention is not specifically guided to the phonetic or the semantic component of compound characters.

The Role of Phonological Processing in Chinese Reading.

Learning to read Chinese is thought to be achieved primarily by visual memory for Chinese characters and direct linkage of orthographic with semantic information (Ehri, 1992; Gough, et al., 1992; Smith, 1985). Until recently, phonological information was considered less important in identifying a Chinese character than in identifying an English word. This view is based largely on the assumption that Chinese orthography is a “deep” orthography with little correspondence between sound and symbol. However, this simplistic visual picture of Chinese reading has been challenged recently. Studies have demonstrated that phonological processes not only play a role in recall and

Perfetti and Zhang (1991) used a priming procedure to demonstrate that phonological information is accessed within the first 50 ms of character identification and that semantic activation does not precede phonological activation in reading Chinese. In their experiments, the subjects were presented a character prime either for 20 ms or for 50 ms. The prime character was followed immediately by a character target which was exposed for 35 ms before being pattern-masked. Primes were selected according to their visual, phonological, or semantic similarity to the target character. The subjects were asked to write down the target. It was found that at the 20 ms duration, neither phonological nor semantic priming was achieved. However, when the prime exposed for 50 ms, both homophonic and semantic primes facilitated target identification. Furthermore, parallel studies with English and other alphabetic systems revealed a high sensitivity of phonological information to temporal factors (see Frost, 1998 for a review). These studies suggest that phonological activation occurs universally across different writing systems. Perfetti, Zhang & Berent (1992) argue that regardless of differences in writing systems, word identification is a continuous and interactive process with different types of information contributing to it at different points of time. A series of recent studies suggest that phonological processing in Chinese word recognition appears to be a robust phenomenon of
broad generality, observable across a variety of tasks (see Tan & Perfetti, 1998, for a detailed review).

Ho and Bryant (1996, 1997c) examined the development of phonological awareness of Chinese children and its relationship with their success in reading. Ho and Bryant (1996) found that Chinese children, like English-speaking children, were able to detect relatively large sound segments (e.g., partial homophones) at the beginning and that gradually they progress to smaller sound segments (e.g., rhymes and tones). However, cross-linguistic comparisons indicated that Chinese children develop an awareness of initial consonants and rhymes later than their English counterparts. It is suggested that differences in the oral and written languages between Chinese and English impact differentially children’s rate of development of phonological awareness. In another study, Ho and Bryant (1997) found that prereading phonological skills significantly predicted children’s reading performance in Chinese 2 and 3 years later, even after controlling for the effects of age, IQ, and mother’s education. The authors suggested that the main reason for this relationship is that phonological knowledge helps children to use the phonetic components in Chinese characters.

Hu and Catts (1993) also found that young Chinese readers in grades 2 and 3 recognize phonologically similar characters less accurately than phonologically dissimilar ones. The phonological confusion effect varied with degree of phonological similarity among characters read. While characters with different rimes and different tones were recognized most accurately, characters with same
rimes but different tones were recognized less well, and characters with the same rimes and same tones were recognized most poorly. These results suggest that beginning readers of Chinese represented Chinese characters phonologically in working memory. Therefore, phonological recoding may be a universal process implicated in reading.

Support for the universal role of phonological processing in reading also comes from the evidence that Chinese children with reading difficulties suffer from phonological processing impairments, consistent with those found in poor readers of English (e.g., Snowling, 1995). So and Siegel (1997) found their fourth-grade poor readers performed at a similar level on a reading task to first-grade normal readers. Despite this they performed much worse than the young normal children on tests of tone and rhyme discrimination, but no worse than them on other tests of language ability that did not involve reading. Lee (1997) showed that their poor readers performed worse than the younger comparison group (matched on reading level) both on a test of phoneme deletion and on a test which involved reading words and pseudowords written in Zhu-Yin-Fu-Hao. These children, however, performed at a similar level to the comparison group on a test of visual memory that involved recognition memory for unfamiliar Greek and Japanese symbols. These findings suggest that as in children learning to read English, reading problems in Chinese children may be directly related to phonological processing ability.
However, there is some disagreement on the role of phonological processing in reading Chinese. Ju and Jackson (1995) examined the effects of graphic, phonological, and graphic-and-phonological information on Chinese character identification. The results indicated that graphic information plays an essential role in Chinese character identification. The presence of phonological information, in combination with graphic information did not improve the accuracy of Chinese character identification as it did English word identification. Huang and Hanley (1994) examined the relation between phonological awareness and learning to read Chinese. They observed that phonological awareness was significantly correlated with reading Chinese characters in Chinese third graders. However, multiple regression analyses indicated that when the effects of IQ and vocabulary skills were partialled out, the performance of Chinese children on phonological tests was no longer significantly related to their reading ability. This is in contrast to the results on English speaking children which show a significant correlation between phonological awareness and reading even when these factors had been partialled out. The results also showed that a test of visual skills (visual paired associates learning) was significantly related to the reading ability of the children in Hong Kong and Taiwan, but not to the reading of the British children. Therefore, this finding did not support the view that differences in phonological awareness per se are a primary and stable cause of differences in reading ability amongst children learning to read Chinese.
Seidenburg (1985) pointed out that phonology only enters into the processing of low frequency words. As is the case in English, in the Chinese writing system a large pool of high frequency words is recognized on a visual basis, without phonological mediation. When Chinese native speakers named high- and low-frequency Chinese characters containing phonemes that provide information relevant to pronunciation (phonograms), analogous to regular words, and non-phonogram characters, the naming latencies for phonograms and non-phonograms did not differ reliably for high frequency characters. However, for lower frequency characters, phonograms were named faster than non-phonograms.

To summarize this part of the review on phonological involvement in reading Chinese, there is now strong evidence for a generalized phonological activation across writing systems: 1) early phonological activation in Chinese word recognition by Chinese adult readers has been demonstrated in Perfetti and his colleagues' studies; 2) there is evidence for phonological involvement in learning to read Chinese by young Chinese children and the contribution of early phonological skills in predicting Chinese reading at primary level (Ho & Bryant, 1997a, 1997b; see also McBride-Chang & Ho, 2000; Shu, Anderson, & Wu, 2000); 3) Chinese children with reading problems perform poorly on tests of phonological processing ability (Lee, 1997; So & Siegel, 1997). However, the argument about the role of visual processing in reading Chinese characters is still going on among some researchers.
Second Language (L2) Acquisition

In this section we are going to turn to the main issue pertinent to this thesis, namely, second language acquisition. The issue of critical period in second language reading has been receiving more and more attention in L2 reading literature. The debate concerning the universal and language-specific processes in reading and writing a second language is still going on with ample evidence supporting each perspective.

Critical Period Effects in L2 Learning.

The critical period hypothesis in first language acquisition, as advanced by Lenneberg (1967), claims that language acquisition must occur before the onset of puberty in order for language to develop fully. However, this hypothesis left open the question of whether this critical period extended to second language acquisition, which could occur after a first language was already in place.

Johnson and Newport (1989) tested the critical period hypotheses proposed in first language acquisition in the context of second language learning. The results show a clear and strong relationship between age of arrival for Chinese speakers (native Korean) in the United States and performance in English grammar, using a grammaticality judgment task. Subjects who began acquiring English in the United States at an earlier age obtain higher scores on the test than those that began later. There was no significant difference in grammatical knowledge between the group with age of arrival of 3-7 and the native language group.
However, some researchers argue that older learners acquire a second language at a more rapid rate than younger children (August & Hakuta, 1997). This is mainly due to stronger first language proficiency and higher linguistic awareness among older children contributing to better second language learning (Lundberg, 1999). Collier (1988) also suggested that children between the ages of 8 and 12 are the most advantaged second language learners in Sweden. This is the period when Swedish children start to learn their first second language, usually English. It seems that this rather late start had not had any drawback.

The debate on the age-of-onset issue of second language is further challenged by the view that it is the first language similarities and differences that actually playing an important role in second language acquisition. The difficult structures, where there are differences between a first and second language, could be the ones that will be less successfully acquired by older than by younger learners, whereas shared structures may be easier and acquired at any age (Marinova-Todd, 1994; Slaff & Johnson, 1995; Yew, 1995; see also Bialystok, 1995; Harley & Wang, 1997 for a review). Now we will turn to the next section which addresses the theoretical framework on the role of similarities and differences in L2 learning.

Theoretical Frameworks.

In this section we review two major positions on the role of first language in second language acquisition: Language-specific view and universal processing
view. Support for language-specific view comes from the following hypotheses: the Contrastive Analysis Hypothesis and Markedness Differential Hypothesis from early linguists, and Orthographic Depth Hypothesis from reading researchers. We will review each of them as follows.

*The Contrastive Analysis Hypothesis & Markedness Differential Hypothesis*

Early linguists have made enormous efforts trying to explain and foresee the difficulty facing second language learners (see Wade-Woolley, 1996 for an overview). One classic example was Lado’s Contrastive Analysis Hypothesis (CAH). Lado (1957) claimed that "in the comparison between native and foreign language lies the key to ease or difficulty in foreign language learning" (p. 1). He argues that it is crucial to compare the differences, at various linguistic levels, between first and second language in order to gain a better understanding and predict the difficulties with which the second language learners will face. As Lado (1957) posited, "we assume that the student who comes in contact with a foreign language will find some features of it quite easy and others extremely difficult. Those elements that are similar to his native language will be easy for him and those elements that are different will be difficult" (p. 2).

However, subsequent research showed that CAH has several limitations. First, predictions based on the comparisons of native language and second language were not noticed reliably across individuals (Glass, 1988, see also Wade-Woolley, 1996). Second, some commonalities were discovered between the native language and second language learners. For example, similar error types were
noted in second language learners and young children acquiring their first language (e.g., Dulay & Burt, 1975; Ervin-Tripp, 1974, see also Wade-Woolley, 1996). A more universalist position was taken by McLaughlin (1978), who states, "There is a unity of process that characterizes all language acquisition, whether first or second language, and ... this unity of process reflects the use of similar strategies of language acquisition" (p. 206).

Due to these limitations of CAH linguists began to look for alternative hypotheses to better explain the complex process of second language learning. One approach proposed by Wardhaugh (1974) was to distinguish between a "strong" and a "weak" version of CAH. According to Wardhaugh (1974), "In contrast to the demands made by the strong version, the weak version requires of the linguist only that he use the best linguistic knowledge available to him in order to account for observed difficulties in second-language learning. It does not require what the strong version requires, the prediction of those difficulties and conversely, of those learning points which do not create any difficulties at all." (p. 81). The main feature of the weak version is that no predictions are attempted regarding what errors the second language learners will make. Instead, linguists working with this framework attempt to explain in a post-hoc fashion errors made by L2 learners (see also Wade-Woolley, 1996).

Another approach that emerged later was known as the Markedness Differential Hypothesis. The main difference between this hypothesis and the earlier versions of either the strong or the weak CAH was that it considers
universal processing components in learning a L2. For example, under the umbrella of Chomsky’s Universal Grammar (UG), researchers like Eckman (1987) proposed the notion of “typological markedness” to determine the “relative degree of difficulty” in the order of acquisition of various structures in a second language. According to Eckman, the markedness is defined as:

A phenomenon A in some language is more marked than B if the presence of A in a language implies the presence of B; but the presence of B does not imply the presence of A. (Eckman, 1987, p. 60).

An illustration of how the markedness principle can be used for the study of L2 learning can be found in Wade-Woolley (1996). She points out that in some languages, the onset syllables can have only one consonant (e.g., the one-syllable structure of Japanese as well as Chinese). In other languages one or more consonants can exist at the onset syllables (e.g., the CV structure, “cat”; CCV structure “stop”; or CCCV structure, “street” in English). It seems, therefore, that having more than one consonant in syllable onsets is not a requirement for all languages in the world. If in a language more than one consonant is present in a syllable onset, this implies that there must exist one-consonant onset in that language, but not the reverse. Based on the definition of markedness, one would assume that multi-consonant onsets are more marked than uni-consonant onsets.

Further, Eckman (1987) developed the Markedness Differential Hypothesis as an alternative to compensate the limitations of CAH for better explaining the ease and difficulty in learning a L2. According to Eckman (1987):

Markedness Differential Hypothesis (MDH): The areas of difficulty that a language learner will have can be predicted on the basis of a systematic
comparison of the grammars of the native language, the target language and the markedness relations stated in universal grammar, such that,

(a) Those areas of the target language which differ from the native language and are more marked than the native language will be difficult.

(b) The relative degree of difficulty of the areas of the target language which are more marked than the native language will correspond to the relative degree of markedness.

(c) Those areas of the target language which are different from the native language, but are not more marked than the native language will not be difficult (Eckman, 1987, p. 61).

For example, evidence supporting this hypothesis was shown in Wade-Woolley (1996) in which Japanese subjects performed poorly in segmenting consonant clusters compared to English-speaking counterparts because the consonant clusters are more marked in English than in Japanese.

The above often-quoted definition of Chomsky's MDH provides an excellent hypothetical framework for predicting and explaining what difficulties a second language learner will encounter. As Eckman argues, the contribution made by the MDH is that it tried to resolve the controversy between whether second language learning errors are due to interlingual or intralingual interference. The notion of the interlingual interference is the core of the CAH, whereas the intralingual interference is central to UG (Wade-Woolley, 1996). According to the MDH (Eckman, 1987), there should be a parallel between first and second language acquisition errors, which implies a similarity between the two learning processes. It also predicts that the errors a language learner makes will be due, partly, to that individual's first language. Specifically, the errors will be dependent on the first
language to the degree that the areas of difference between the first and second
language are marked in the L2.

There is research evidence to support the MDH in various studies in the
area of syntax and syllable structure (e.g., Altenberg & Vago, 1987; Anderson, 1987;
Eckman, 1987; Wade-Woolley, 1996). Most studies, however, have been carried out
by linguists whose primary interest is to ascertain the importance of markedness
in predicting the ease or difficulty of a second language learner. Many of the
publications are based on theoretical analyses and evidence is mostly based on
anecdotes or case studies (Geva, personal communication). More systematic
research is needed to test these hypotheses with larger samples. More importantly,
it is necessary to study L2 acquisition with a developmental framework which
would offer richer information with regard to the similarities and differences in
learning a second language. The Orthographic Depth Hypothesis discussed in the
next section made an important stride along this line.

Orthographic Depth Hypothesis

Another theoretical framework of more relevance to reading in L2
emphasizing the language-specific processing in L2 reading is the Orthographic
Depth Hypothesis (see Katz & Frost, 1992; Frost, 1994). 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, there is a more complex or opaque relation between letters and sounds. The effects of orthographic depth difference across different writing systems have been shown to affect progress in learning to read and spell (e.g., Caravolas & Bruck, 1993; Cossu, Shankweiler, Liberman, Tola, & Katz, 1988; Durgunoglu & Oney, 1999; Geva, et al., 1993; Frith, Wimmer & Landerl, 1998; Goswami, Gombert & Barrera, 1998; Shimron, 1999).

Caravolas and Bruck (1993) found that Czech ESL children performed better at phoneme deletion than English speaking peers due, in part, to the more regular Czech alphabet. Similarly, Cossu, et al. (1988) found that the shallow orthography of Italian facilitated the phonological awareness of Italian children relative to the English speaking children. Oney and Durgunoglu (1994) suggest that in Turkish, a shallow orthography, the contribution of phonological awareness to word recognition is limited to the very early stages of reading acquisition. The authors reported that Turkish children reach ceilings on word recognition measures by the end of grade one, most likely due to the fact that Turkish is a highly orthographically regular language. It was concluded that phonological awareness facilitates reading acquisition in Turkish only in the earliest stages, unlike English, where the facilitative relationship lasts longer.

Some researchers (e.g., Geva, et al., 1993) further argue that individuals will learn to read and spell accurately faster when a shallow orthography is involved regardless of whether it is the learner’s L1 or L2. The regular structure of the orthography may “override whatever processing difficulties may be imposed by
weaker proficiency in the L2” (p. 384). In Geva, et al. (1993)’s study, 45 children acquire reading and spelling skills concurrently in English (L1) and Hebrew (L2). The less complex Hebrew orthography facilitated children’s decoding performance. However, this facilitation failed to be maintained in spelling performance. The children performed much better in reading than in spelling. The authors reason that Hebrew is deeper for spellers than decoders, as opposed to English in which the difference in terms of orthographic demands on spelling and decoding is not as great as for Hebrew.

There are also a number of studies which demonstrated the effects of orthographic depth in second language learning from a non-alphabetic L1 background (e.g., Akmastu, 1999; Brown & Haynes, 1985; Haynes & Carr, 1990; Holm & Dodd, 1996; Jackson, et al., 1994, 1999; Koda, 1987; 1989; 1998). Note, however, that these studies mainly focused on adult L2 learners. We will devote a section to review this area of literature after the following hypothesis.

**Central Processing (Universal) Hypothesis**

Contrary to the Orthographic Depth Hypothesis, the universal or central processing hypothesis claims that the acquisition of reading skills does not depend on the nature of the different language systems. It posits that underlying cognitive processes play an important role in reading first language and second language. Underlying cognitive factors such as short term verbal memory, efficient serial naming and linguistic components such as phonological skills may not only be
essential in reading L1 (e.g., Stanovich, Cunningham & Feeman, 1984; Hu & Catts, 1993; Cossu, et al., 1988), but also in reading L2.

Evidence supporting the universal view comes from various sources. First, a number of studies have shown that there exists a universal phonological process in reading across different language systems, and earlier notions about the absence of phonological processes in reading logographic languages has been refuted (e.g., Perfetti & Zhang, 1991, 1995; Seidenberg, 1985; Tan & Perfetti, 1998). This body of literature has been reviewed in the previous section. The second source of evidence comes from various studies which suggest that reading problems do not differ among children learning to read logographic and alphabetic languages. Stevenson and his colleagues (1982) have demonstrated that the prevalence of dyslexia is comparable among American, Japanese, and Chinese children. Ho, Law and Ng (1998) found that the phonological deficit hypothesis is also relevant to Chinese developmental dyslexia, that is, Chinese dyslexia children have real deficits in processing phonological information as their alphabetic counterparts. Ho and her colleagues (1999) further showed the effectiveness of training phonological strategies in improving Chinese dyslexic children’s reading performance.

The third source of support for the universal position comes from cross-language transfer studies across different orthographies. The cross-language transfer hypothesis was formally presented by Cummins (1979) as the Linguistic Interdependence Hypothesis. This hypothesis suggests that once the child develops reading skills in the native language he or she is able to transfer those
skills to the second language. Support for cross-language transfer comes mainly
from recent studies in cross-language transfer of phonological awareness. Research
with L1 children has demonstrated convincingly the relationship between
phonological awareness and reading acquisition. Durgunoglu, Nagy and Hancin-Bhatt (1993) further demonstrated the relationship between phonological
awareness in Spanish and word recognition in English. Children who could
perform well on Spanish phonological awareness tests were more likely to be able
to read English words and pseudowords than were children who performed
poorly on phonological tests. Moreover, phonological awareness was a significant
predictor of performance on word recognition tests both within and across
language. Similar results were found in Cisero and Royer (1995) in which L1
performance in phonological awareness tasks was a significant predictor of the
gain in L2 (Spanish for English-speakers and English for Spanish-speakers)
performance in the similar tasks from time 1 to time 2.

Comeau, et al. (1999) not only validated the findings from the above two
studies with English-speaking children learning French, but also extended both
sets of skills of phonological awareness and word reading in both languages. Their
study provides evidence that cross-language transfer occurs for phonological
awareness and word decoding. Phonological awareness in English, the L1 was as
strongly related to achievement in word decoding in L1 as phonological awareness
in French, the L2. Likewise, phonological awareness in L2 was as strongly related
to achievement in word decoding in L2 as phonological awareness in L1. In
addition, this study went further than the other two by investigating the role of three phonological processing skills (phonological awareness, verbal working memory and lexical access) in reading, rather than phonological awareness alone. They found that the relation of phonological awareness with achievement in reading was stronger and more resilient than that of verbal working memory and lexical access with reading.

Taken together, these findings suggest that some kinds of universal processes underlie the acquisition of first language and second language. Facing the two kinds of seemingly contradictory hypotheses regarding L2 learning, that is, language-specific or universal processing model, some recent research provides evidence that supports both claims. These researchers suggest that these two alternatives are not contradictory but complementary. For example, Geva and Siegel (2000) demonstrated the significant role played by verbal memory in predicting basic reading skills in both L1 (English) and L2 (Hebrew), which provides moderate support for universal processing position. Meanwhile, it was also found that children could read more accurately voweled Hebrew (a "shallow" orthography) than English (a "deep" orthography), and that the decoding errors are orthography-specific. Similar findings were revealed in Gholamain and Geva (1999) with children learning to read L1 (English, a "deep" orthography) and L2 (Persian, a "shallow" orthography). Both studies concluded that this joint consideration of both positions presents a more complete as well as a more productive framework for studying second language reading development. The
present study is intended to provide some further evidence of this complementary model from a developmental perspective.

The Role of L1 Orthography: Evidence from Chinese ESL Reading

A number of researchers have attempted to examine the role of first language orthography in L2 reading by Chinese ESL (English as second language) readers compared to native English readers. Results of these studies are consistent with the notion that Chinese readers of English tend to rely more on an orthographic word identification strategy than English readers do. Haynes and Carr (1990) compared Taiwanese and American undergraduates' visual efficiency skills in making visual same-different judgments about orthographically irregular (i.e., illegitimate) four-letter strings, orthographically legitimate four-letter pseudowords, and real four-letter words. In each item, there was a pair of stimuli which either matched exactly or differed by one character. Beside each pair were the letters s and d. The subject was to circle the s if the stimuli pairs were the same, d if they were different. Subjects were instructed to respond as quickly as possible without making mistakes. Response times were recorded for the set of items as a whole. As one would expect, both groups judged the real words most efficiently. However, the authors' primary interest was in the extent to which the groups differed in efficiency gains as the stimuli became more familiar. A matching efficiency score was computed for each stimulus type for each subject, defined as the number of correct responses per minute on the appropriate stimulus list. Then
they computed difference scores which they labeled as a lexicality effect (word-pseudoword efficiency) and an orthography effect (pseudoword-letter string efficiency). The results revealed that the native Chinese readers gained relatively little advantage from the orthography effect and relatively more advantage from lexicality, compared to American English readers. That is, Chinese readers do not benefit as much from predictable or well-structured sequencing of letters as do their American counterparts. The authors interpreted this finding as evidence that Chinese readers are inefficient at detecting legitimate but novel orthographic sequence within English words.

The weak orthography effect of Chinese ESL adults manifested in the above study has been also demonstrated in Koda (1987; 1989) on Japanese ESL adults. She found that Japanese ESL readers, literate in Kanji symbols borrowed from Chinese, performed better in the recalling of a string of unpronounceable letters than in the recall of a string of phonological similar set of letters, that is, phonological coding among Japanese subjects was seriously impaired by phonological similarity, but not by either graphic similarity (phonological dissimilarity) or unpronounceability. It is argued that phonological inaccessibility has fewer negative effects on morphographic readers (e.g., Japanese, Chinese readers) than on phonographic readers because morphographic readers rely less on phonological information presented in the graphemic representation to form a phonological code than do phonographic readers, whose phonological coding of necessity involves a direct analysis of phonological information in the graphemic representation.
Jackson and her colleagues (Jackson, Lu, & Ju, 1994), however, argue that making a judgment about the visual similarity of letter strings may not be a purely orthographic task for Chinese ESL readers. What Haynes and Carr interpret as an orthography effect might also be a phonology effect; the Chinese ESL readers’ deficit in matching English pseudowords could also be attributed to difficulty in coding phonologically unfamiliar letter strings. Jackson, et al. (1994) examined orthographic and phonological processing among Chinese ESL readers, and also found that native Chinese readers are better able to process orthographic information than they are at processing grapheme-phoneme-correspondences. The Taiwanese graduate students were slower and less accurate than the American ninth graders on all four timed word identification tasks. However, the pattern of results also suggested that the native Chinese readers were better at orthographic than at phonological processing when reading English. Their accuracy and speed scores on the two orthography tasks were at about the levels expected from their reading test, whereas their accuracy score was poor on both of the phonological processing tasks.

Akamatsu (1999) also demonstrated the effect of orthographic characteristics on word recognition in Chinese ESL readers. Unlike other researchers, he did not use orthographically illegitimate letter strings or pseudowords, but real words. He used lowercase and case-alternated words (e.g., cAsE aLtErNaTiOn) to examine the ESL reader’s sensitivity to sequences of constituent letters. It was found that the Chinese and Japanese ESL readers (with a non-alphabetic L1 background) were
more impaired by case alternation than the Iranian ESL readers (ESL readers with an alphabetic L1 background) in word reading. It seems that the visual disruption of word-shape cues (i.e., mixing lower and upper cases in a word) affected ESL readers who have a non-alphabetic L1 background. On the other hand, alphabetic L1 readers experienced little effect of this visual disruption of word-shape. The crucial reason for this difference, according to the author, is that in non-alphabetic orthography "the transformational processing of words into mental representations does not involve the computational processing of sequences of the constitutional letters in words" (Akamatsu, 1998, p. 19).

Recent research, however, points out that such a difference in reading a second language by Chinese readers may vary depending on their Chinese or English instructional history (Holm & Dodd, 1996; Jackson, et al., 1999). Holm and Dodd (1996) made use of differences between ESL readers from People’s Republic of China and Hong Kong in experience with transliterations of Chinese characters, comparing the performances of University of Queensland students from each of these countries on a set of English phonological awareness, reading, and spelling tasks. Students from Vietnam (which has a Roman-based alphabetic written language) and natives of Australia also were studied. The students from Hong Kong read and spelled real English words about as well as the other ESL groups. However, they were dramatically less competent than all of the other ESL readers on a set of phonological awareness tasks and in reading and spelling nonwords. The authors interpret this difference as the result of the Hong Kong students’ lack
of exposure to an alphabet in learning their first written language, that is, ESL learners transfer their literacy processing skills from their L1 to L2. When the phonological awareness required in English had not been developed in L1, ESL students from Hong Kong relied more heavily on a whole-word, visual strategy.

However, in Jackson, et al. (1999)'s study, they did not find Chinese students from Hong Kong to be inferior in performance to readers of Chinese from Taiwan who had had early exposure to an alphabetic transliteration of Chinese when the task required processing novel English Grapheme-Phoneme- Correspondences. They suggest that the nature of an ESL reader’s L1 orthography may be less important than the timing and nature of the reader’s exposure to a second language and writing system.

Similarly, Koda (1998) found that ESL Chinese with logographic background and ESL Korean with alphabetic experience differed neither in their phonemic awareness nor in decoding. Strong interconnections existed between reading comprehension, decoding, and phonemic awareness among Korean participants, but no such direct relationship occurred among Chinese. However, a major group distinction was found between the two groups in the correlational patterns involving phonemic awareness and decoding. While the correlations were, in general, highly consistent across variables in the Korean data, a clear contrast exists in the correlational patterns between the two decoding scores in the Chinese data: phonemic awareness correlates highly with word attack but not with homophone detection (Olson, et al., 1983's task). Hence, she suggests that L2
learner’s prior processing experience may interact with task requirements in building L2 processing procedure. She further argues that the performance differences among L2 readers cannot be explained through a simplistic analysis of L1 variables. In order to get a better understanding of L2 reading development, one should go beyond the “unidimensional” analysis of L1 variables. Attention should also be given to explore the complex interaction between learners’ prior processing experience and the varying cognitive/linguistic demands imposed by different tasks.

**Previous Research on L2 Children’s Spelling Performance**

Very few studies have examined L2 children’s spelling performance and the relationship to reading and other necessary underlying component processes such as phonological and orthographic skills. Geva, Wade-Woolley, and Shany (1993) tested the contrasting hypotheses that lack of proficiency in L2 or differences in orthographic complexity could explain the difference between L1 and L2 reading and spelling performance in a group of children acquiring reading and spelling skills concurrently in English (L1) and Hebrew (L2). The results showed that the profiles of emergent spelling in both languages are quite similar from Grade 1 to Grade 2. However, the pace at which children reach the standard spelling differentiates L1 from L2, with a clear advantage to the L1. Interestingly, it was also found that there were “peaks” and “valleys” noted in Hebrew Grade 2 profile. This indicated that some Hebrew words were spelled at different developmental levels,
with some of them at a particular low level. The authors further conducted error analyses on these items, and found that one source of difficulty lies in the items which were homophones and which require special attention to orthographic rules such as letter shape in final position. Therefore, it was argued that although overall developmental trajectories associated with L1 spelling acquisition are mirrored in L2 spelling development, specific difficulties in L2 such as the "opaque" orthographic elements impose higher task demands. Furthermore, the authors suggested that "when an L2 effect is noticed, it is not generalized, but rather, can be localized to specific processing areas affecting phonological or orthographic feature." (p. 403).

Fashola, Grum, Mayer, and Kang (1996) examined phonetic and orthographic sources of spelling errors for Spanish-speaking (L1) children who were transitioning to literacy in English (L2). In particular, they examined spelling errors for eight English allophones (e.g., /k/ and /h/) that could be predicted on the basis of the application of correct Spanish phonological and orthographic rules to English words. They found on a dictation task that Spanish-speaking students produced significantly more spelling errors that were consistent with the Spanish phonological and orthographic rules than did English-speaking students. The groups did not differ in their production of other kinds of random or nonpredicted spelling errors. The younger (second and third grade) children made more predicted and nonpredicted errors than did older children (fifth and sixth grade). Moreover, it was also found that there was no significant interaction between
language status and grade level for predicted errors, whereas there was a significant interaction with respect to nonpredicted errors. This interaction pattern indicated that the number of nonpredicted errors made by L1 children declined significantly more than L2 children from younger to older grades. This result suggests a general low level of spelling performance by L2 children compared to L1 children even till high primary level. One limitation of this study is that it did not attend to the relationship between spelling and other important underlying component processes such as phonological awareness and word decoding skills.

Another recent study by Wade-Woolley and Siegel (1997) found that language status was not a dominant factor in the spelling performance of ESL children (from Asia and India) who spelled as accurately as the non-ESL group, despite poorer phonological processing. The researchers argue that spelling performance does not appear to reflect differences in oral language competence. Despite the recognizable impairment of ESL children on phonological tasks relative to native speakers, this difference was not apparent in spelling real words or pseudowords. ESL learners appeared to benefit to the same degree as native speakers from the presence of lexical entries when spelling frequent real words. Moreover, reading skill had a much more significant influence on spelling accuracy than did first language. In every analysis of spelling accuracy, average readers were more accurate than poor readers. The depressed ability of the poor readers to perform phonological tasks was consistently evident in their lower spelling accuracy in every analysis. The authors argued that since the ESL children spelled
as accurately as the L1 children despite poorer phonological processing it would be expected that there exist strong dissimilarities in the patterns of underlying processes of ESL and L1 spellers. However, further analyses provided evidence for the similarity in the patterns of underlying processes between ESL and non-ESL in spelling. The accuracy of real word spelling was predicted by pseudoword decoding and phoneme deletion in similar proportions for both ESL and non-ESL groups. Pseudoword decoding was the only significant predictor of pseudoword spelling, predicting equal variance for both language groups. However, in their study, only one age group (grade 2) children were tested. The extent to which the results extend to other age groups needs further research and subtle differences could be detected with the examination of other age groups. In the present research, the development of spelling from grade 1 to grade 2, and the contributions of various aspects of phonological processing to spelling at different stages was examined. The second limitation which the authors did not acknowledge is that they grouped all ESL children together (Chinese and Eastern Indian ESL children) for the analyses, based on their equal performance on two phonological tasks, while ignoring the possible difference between these two language groups on spelling tasks and other oral proficiency measures.

Consistent with the Wade-Woolley and Siegel’s findings, Holm and Dodd (1996) also found that even though the Hong Kong university students (with non-alphabetic first language literacy) had limited phonological awareness compared to those students with alphabetic first language literacy, the reading and spelling
tasks showed no differences between the groups on real word processing. According to these authors, the results from these Hong Kong students indicate that English spelling can be acquired without phonological awareness. It is suggested Hong Kong subjects may use a "global strategy" when they spell real words. However, they had difficulty with nonword spelling which was mirrored by their deficiency in nonword reading, although all the groups made more errors spelling nonwords than the real words. It was found that neither analogy nor grapheme-phoneme correspondences were used effectively by the Hong Kong group to spell nonwords. This result from adult ESL readers was in contrast with Wade-Woolley and Siegel (1997)'s finding that ESL children benefit to the same degree as native speakers by the presence of lexical knowledge of the real words.

In sum, the existing literature on L2 spelling, albeit limited, supports the notion of language transfer in L2 learning. Consistent with the theoretical frameworks reviewed, this L1-specific processing effect seems to be limited only to specific contrastive linguistic elements between L1 and L2, not generalized to all components of L2 learning. At the same time, the universal processing part of L2 learning could be seen in studies showing similar spelling performance between English-as-L1 and L2 children, which led some researchers (such as Wade-Woolley & Siegel, 1997) to argue that it is the reading skill (i.e., poor, average or good readers) that determines the spelling level, rather the nature of the first language. Evidence of a close relationship between spelling, decoding and phonological processing skills in both L1 and L2 also provides support for common underlying
cognitive processes in learning L1 and L2. The unique characteristics of Chinese phonology and orthography present an interesting opportunity to examine this interaction between language-specific and universal processes in L2 acquisition. In the present study, children’s spelling performance was investigated in a longitudinal framework to test the different roles of L1 transfer and universal processing in different stages of learning a L2.
CHAPTER 3: THE PRESENT STUDY

Research Questions

The present study had two purposes. The first was to examine the development of spelling in Chinese primary level ESL children compared to non-ESL children over a two-year period of time. The effects of L1 on ESL learning were to be analyzed in depth. As was discussed in the literature review, with only one study looking at the spelling development over time in Hebrew-as-L2 learning (Geva, Wade-Wooley, & Shany, 1993), there has been little research conducted on ESL’s spelling development in general, and Chinese ESL children’s spelling development in particular. The present study attempted to further examine the effect of novel phonological features on learning L2 by these children and the influences of lexical and orthographic knowledge on Chinese ESL children’s spelling performance. Thus, the first two research questions to be examined in the present study are as follows:

1. Do young Chinese ESL children learn to spell in the same way that native English speaking children do; how does the fact that their L1 does not include certain phonemes, such as “sh” and “th”, affect the spelling of these phonemes in Chinese ESL children, does this effect persist over the time?

2. How does lexical and orthographic knowledge influence the spelling performance of ESL and L1 children?
It was hoped that in answering these questions evidence of the effects of L1 transfer and potentially universal developmental trajectories in learning to spell in L2 would be obtained and a better understanding of the interaction between universal and language-specific processes in L2 learning would be achieved.

The second purpose of this study was to explore the relationship between spelling, reading, and phonological processing in Chinese ESL children. As was previously discussed, there has been a large amount of literature documenting these relationships in English-as-L1 children, and a general consensus on the close connections between those processes in L1 children. There have been, however, limited studies exploring these relationships in ESL children, and particularly in a longitudinal framework. Studying ESL children's reading and spelling longitudinally is important for at least two reasons. First it can eliminate some confounding factors that may be involved in cross-sectional studies, such as different educational experiences among the different age groups, known as the cohort effect. Second, and perhaps more importantly, through longitudinal study the impact of early ESL children's component processes such as phonological awareness as well as language proficiency and non-verbal ability on later reading and spelling performance in normally achieving children can be examined. Hence, the third question addressed here is:

3. Does the nature of the relationship between spelling, reading, and phonological processing in Chinese ESL children mirror that noted in L1 children? Are these relationships consistent across the time?
Hypothesis

Based on Geva, Wade-Woolley and Shany (1993)'s findings, it is hypothesized that Chinese ESL children will undergo a similar developmental pattern in spelling skills to that of English-as-L1 children. However, language-specific processing hypotheses of learning L2 such as the Contrastive Analysis Hypothesis would predict that Chinese ESL children have more difficulty in spelling words with phonemes which are absent in their L1 than with phonemes which are present in the L1. This will be consistent with Fashola, Grum, Mayer, and Kang (1996)'s findings. As to whether this L1 negative transfer effect\(^1\) is persistent across different grade levels, it is reasonable to hypothesize that with time the performance of English-as-L1 and young ESL children will converge as a result of increased proficiency in L2 coupled with the impact of literacy instruction in English. However, it is not clear how long the effect of negative transfer from the L1 persists.

With regard to the second research question, due to the fact that L2 learners may have limited lexical knowledge in their second language, the effect of lexicality might not be as strong in L2 learners (Geva, et al., 1993). However, according to the research findings in Wade-Woolley and Siegel (1997) and Holm and Dodd (1996), the ESL learners may benefit to the same degree as native

\(^1\) In this thesis, negative transfer refers to any influence from L1 that impedes the performance in L2, whereas positive transfer refers to any influence from L1 that facilitates L2 performance.
speakers when spelling frequent real words. In other words, both L1 and ESL children should have greater difficulty with pseudoword spelling than with spelling real words.

There is another possibility though, which considers the joint effects of lexicality and specific L1-related transfer. According to this hypothesis, both L1 and ESL children will have more difficulty with spelling pseudowords than with spelling real words. In addition, Chinese children will demonstrate even more difficulty when the pseudowords contain unfamiliar phonemes. In other words, there will exist a significant interaction between the variable of language group and lexicality. Generalizing from previous research on Chinese L1 and L2 readers' strong orthographic processing skills (e.g., Haynes & Carr, 1990; Koda, 1987, 1989), it is predicted that Chinese ESL children will have better performance than L1 children in recognizing correct spellings. The effect of visual-orthographic processing will be strong in Chinese ESL children, that is, Chinese ESL children will outperform L1 children in spelling visually presented items. The difference in spelling performance between orthographically legitimate and orthographically illegitimate items will be smaller for Chinese ESL children than for L1 children. This strong visual-orthographic effect in favor of Chinese ESL children will still be evident even when the items contain L1-specific elements.

The relationships between spelling, reading, and phonological processing, are expected to be positive within the L1 group (Bruck & Treiman, 1990; Gough, et al., 1992; Ehri & Robinson, 1992; Liberman, et al., 1974; Read, et al., 1986; Treiman,
1993). Cross-language transfer research also has shown ample evidence supporting a close relationship between these underlying components in learning L2 and as well as the transfer effect of these close relationships from learning L1 to learning L2 (e.g., Cisero & Royer, 1995; Comeau, et al., 1999; Durgunoğlu, et al., 1993; Geva, et al., 1993; Wade-Woolley & Siegel, 1997). Therefore, it is predicted that there will exist the same close relationships as well as the patterns of underlying processes for Chinese ESL children as those for L1 children across time.

Method

Subjects.

The present study forms part of a larger project currently underway, which was designed to explore the development of various indices of ESL children’s oral language and literacy skills over a three-year period. Literacy development in ESL primary level children is compared to that of a control group of English-as-L1 children. The present study involves a total of 72 children drawn from 8 public elementary schools in two multi-ethnic suburbs of a large Metropolitan area. There were 35 Chinese children, 19 girls and 16 boys whose first language is Cantonese. They have been identified as ESL students by their schools and teachers. The mean age was 6; 4 at Time 1 at the beginning of Grade 1, ranging from 5;10 - 6;10. According to Johnson and Newport (1989), this is an optimal age period for L2 children learning English as a second language. A preliminary survey showed that all the Chinese ESL children, except for one, attend weekend Chinese heritage
language classes, in which the child can receive instruction in reading and writing Chinese. Some children also participate in special tutoring classes offered by Chinese instructors after school hours or on weekends on some particular school subjects such as math (Lam, 1999). Thus, although at school the Chinese children are being taught in English only, they have exposure to literacy instruction in their native language.

Thirty-seven children were native English speakers, 21 were girls and 16 boys. The mean age of the L1 group at Time 1 was 6;5, ranging from 5;11 - 6;11. Table 1 summarizes the information about subjects at each of the 4 testing times. The mean age and range at different times for the 2 language groups matched well.

Table 1.

Subjects' Information (Number, Age and Sex) at 4 Testing Times

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 No.</td>
<td>37</td>
<td>37</td>
<td>33</td>
<td>29</td>
</tr>
<tr>
<td>Age:</td>
<td>6;5</td>
<td>6;10</td>
<td>7;4</td>
<td>7;10</td>
</tr>
<tr>
<td>range</td>
<td>5;11 - 6;11</td>
<td>6;4 - 7;4</td>
<td>6;10 - 7;10</td>
<td>7;4 - 8;3</td>
</tr>
<tr>
<td>Sex</td>
<td>21 F, 16 M</td>
<td>21 F, 16 M</td>
<td>20 F, 13 M</td>
<td>16 F, 13 M</td>
</tr>
<tr>
<td>ESL No.</td>
<td>35</td>
<td>34</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>Age:</td>
<td>6;4</td>
<td>6;9</td>
<td>7;3</td>
<td>7;9</td>
</tr>
<tr>
<td>range</td>
<td>5;10 - 6;10</td>
<td>6;4 - 7;4</td>
<td>6;9 - 7;10</td>
<td>7;4 - 8;3</td>
</tr>
<tr>
<td>Sex</td>
<td>19 F, 16 M</td>
<td>19 F, 15 M</td>
<td>17 F, 13 M</td>
<td>17 F, 12 M</td>
</tr>
</tbody>
</table>

Note. T1= Time 1, T2 = Time 2, T3 = Time 3, T4 = Time 4
Design.

In this longitudinal study, the test batteries were administered twice a year (fall and spring) over a 2 year period. Time 1 testing took place in the fall term of grade 1, Time 2 testing in the spring term of grade 1, Time 3 testing in the fall term of grade 2, and Time 4 testing in the spring term of grade 2.

Measures.

Spelling Measures

Four different spelling measures with different task demands were administered:

1. Real word spelling

The Developmental Spelling Test was used to assess emergent spelling in English, and examine children's knowledge of phonological and orthographic elements and word patterns. The test consisted of 16 simple and highly frequent words that have been included on the basis of orthographic representations of specific morphological structures such as plural forms (cats, dogs), tense forms (wanted, peeked, flying), and phonological patterns such as consonant digraphs where phonemes were represented by more than one letter (ship, then, teeth, thick) or consonant clusters (stick, please, flying). The child heard each word in isolation and in sentence context, and was then asked to write down the word they had heard (see Appendix A).

Three scoring systems, varying in level of specificity, were used to code various levels of spelling knowledge in English. First, an overall measure of
absolute accuracy was taken. The words were scored as either correct or incorrect according to the rules of conventional spelling, and the percentage of correctly spelled words was calculated.

Because spelling is a complex process, however, a right-wrong dichotomy provides little information about the developmental processes of spelling acquisition. In order to rate spelling along a developmental continuum, a more sensitive rating system was needed. The second scoring scheme in the present study was adopted from Liberman, et al. (1985) and Mann, et al. (1987)'s quality point systems. It was designed to determine developmental levels of spelling in children at kindergarten and first grade. The scale was built based on two main features of children's spelling: the number of phonemes that the child represented and the level of orthographic representation. This system has been found to be sensitive to early spelling development and has been adopted by other researchers in recent studies (e.g., Tangle & Blachman, 1992, 1995). The scoring system was as follows:

0 point: a random string of letters
1 point: consonant or vowel, but not the initial one
2 points: initial consonant plus other segments
3 points: all salient phonemes or phonetic segments; must include a vowel

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2 Any spellings with only initial consonant were given 2 points as well.
4 points: transitional – vowel combination attempted; silent letters employed;
errors on doubling letters; all phonemes represented

5 points: correct spelling

For example, 4 points were given if the child spelled the word “please” as “pleas”; 3 points if it was spelled as “plis”; 2 points if it was spelled as “pes”; 0 point if it was spelled with an arbitrary letter such as “d”. Using Time 1 data, interrater reliability for this coding scheme was established using Pearson correlation between two independent raters. The reliability for individual words ranged from .695 to .980. Thus the coding system for scoring the developmental spelling level was reliable. The disagreements were resolved through discussions between the raters.

In the third approach we focused on the spelling error patterns of two specific phonological and orthographic structures (“sh” and “th”). It can be predicted on the basis of Chinese phonology that Chinese children will have specific difficulties with these elements because they do not have phonological representations of these phonemes. Error analysis approach has been widely used in second language acquisition literature to investigate the constrains on transfer from L1 to L2 (e.g., Altenberg & Vago, 1987). It is hypothesized that the ESL children will borrow the closest phonemes from their L1 to represent the absent phonemes in L2. It is also possible that some other phonemes might intrude. Both error frequency (the number of children in each language group) and error types were compared between the 2 groups using Chi-square analyses. The errors were
coded into three categories: phonological errors (e.g., “s” for “sh”), orthographic errors (e.g., “hs” for “sh”), and no letters to represent the phoneme.

2. Pseudoword spelling

In order to control for the impact of lexical knowledge on spelling performance, a list of 16, 4-letter, one syllable pseudowords with a CVCC or CCVC structure was developed (e.g., poth, theg). Research has shown that reading and spelling pseudowords is often more difficult than reading and spelling real words (e.g., Rack, Snowling, & Olson, 1992). However, L2 learners may have limited lexical knowledge in their second language, so this effect of lexicality may not be as strong in L2 learners (Geva, et al., 1993). As noted earlier, Wade-Woolley and Siegel (1997) tested this hypothesis in a group of ESL children, and found that the ESL learners benefit from lexicality to the same degree as native speakers when spelling frequent real words. In the present study we compared Chinese children’s performance on certain phonological elements in pseudowords with the spelling of the same elements in the real word spelling task.

To provide control for orthographic complexity, two consonant digraphs th, and sh, 2 consonant clusters st, and sp were examined in this task. Each of these elements appears at the initial or final positions of two words in the list (see Appendix B). Children’s spellings of each item were scored as either correct or incorrect. The child was given one practice item.

3. Confrontation pseudoword spelling
In this task the child was shown one at a time for 2 seconds a list of 12, 4-letter items. Six of these items were orthographically legitimate and pronounceable pseudowords, e.g., nesh, shen, and 6 were orthographically illegitimate and non-pronounceable letter strings, e.g., nfsh, shfn. The child was asked to write down each word. Haynes and Carr (1990) found that relative to the American comparison group, adult native readers of Chinese gained relatively little advantage from what they called orthography effect (pseudoword - letter string efficiency) and relatively more advantage from lexicality effect (word - pseudoword efficiency). In the present task, this orthography effect was tested in young ESL Chinese children compared with native English speaking children. It should be noted that our ESL children have limited reading experience in their L1, it was not clear whether the effect would be similar to what has been found with adult Chinese readers who were proficient in reading and writing Chinese.

Two digraphs th and sh, and one consonant cluster, st, were examined in this task. Each element appeared twice at the initial or final position of the words. The words were randomly arranged in the list (see Appendix C). One point was given for each correct spelling. The child was given one practice item.


This task was included to assess the child’s ability to recognize the correct spelling of the word from graphemic information, following an auditory presentation of the stimulus. The child was required to listen to a word and select the word that matches the auditory stimulus from a matrix of 4 written stimuli.
The spelling items of the Peabody Individual Achievement Test-Revised (PIAT-R) (Markwardt, 1989) were used. However, the written stimuli were presented on a lap top computer. The audio stimuli were recorded by a female native English speaker and then converted to sound files which were imported into the experiment-programming software Superlab. The child’s task was to point to one of the words on the computer screen that matches the auditorily presented word. The experimenter recorded the child’s answer both on the computer and on the response sheet. There was a total of 100 items in the task. Items 1-12 were practice trials, e.g., selecting a letter when given its sound. From item 13-100, each set of words had a target word of high frequency and three distracters. The distracters varied in terms of the initial, final consonants or the vowel units, for example, target word: car, distracters: kar, karr, cor.

Reading Measures

1. Recognition of the spelled words

The child was asked to read the same 16 words from the real word spelling task in a different testing session. To minimize the effect of having seen the words on spelling this reading task was always administered in a session following the one where these words were being spelled. The scoring was one point per correct reading.

2. WRAT word recognition

To assess children’s ability to read isolated words in English, the word recognition subtest of the Wide Range Achievement Test-Revised (WRAT-R)
(Jastak & Jastak, 1984) was used. This test consisted of 42 unrelated words, beginning with highly familiar and short words, then going to the less frequent, longer, and orthographically more complex ones. One point was given for each correctly read word.

3. Pseudoword decoding.

The Word Attack subtest of the Woodcock Reading Mastery Test-Revised (Woodcock, 1987) was used to assess children’s ability to employ various grapheme-phoneme correspondence (GPC) rules to decode pseudowords. The test consisted of 45 pseudowords which comply with English orthographic rules. One point was given for each correct item.

Phonological Processing Tasks

Researchers generally agree that phonological processing is not a unitary capability, but rather involves a group of component cognitive processes (e.g., Yopp, 1988). In order to reflect different levels of cognitive processes of phonological processing, the following five measures were used: Auditory Discrimination, Rhyme Selection, Oddity, Phoneme Deletion and Phonological Working Memory. It was found that for normal achieving L1 children, rhyme recognition tasks have a low loading on the major factors of phonemic awareness (Stanovich, et al., 1984; Yopp, 1988). Moreover, Yopp (1988) found that auditory discrimination has low correlations with other tests of phonemic awareness. Yet, it is unclear whether these tasks may be sensitive measures for ESL children.

1. Auditory Discrimination Task.
This measure was included to determine the child's ability to recognize the fine differences that exist between the phonemes used in English speech, and trace the relationships between the perception of sound discrimination of phonemes novel to ESL learners and the ability to read and spell words containing these elements. A modified version of the Auditory Discrimination Test (Wepman, 1994) was used. In this version, only pseudowords were used in order to avoid the confounding influence of lexical knowledge on auditory discrimination (see Appendix D). Modifications also included the addition of pseudowords targeting the phonemes that were predicted to be difficult for Chinese ESL children. The task consists of 34 one-syllable pseudowords. Six require the auditory discrimination of the sound /th/, for example, thop-zap, and 5 require the auditory discrimination of /sh/, for example, bish-biss. The child was presented with pseudoword-pairs on a professionally prepared audio-tape. For each item they had to indicate whether the two "words" were the same or different. There were 16 pairs of words which were same, and 18 were different. One point was given for each correct item, with a maximum possible score of 34. There were 3 practice items.

2. Rhyme selection task.

In this experimental task, the child was asked to decide which of three words presented on audiotape rhymes with the previously given target word. In order to reduce memory load and any possible articulation problems, the child was shown three different wooden shapes, each of which corresponds to one of the words, then asked to point to the shape which corresponds to their choice of the
correct word. The same procedure was used in the Oddity task as well. There was a total of 18 items in the rhyme detection task. Among them, 6 contained a rhyme with the sound /sh/, and 6 contained a rhyme with the sound /th/. The remaining 6 items were control items, common to both language groups (see Appendix E). One point was given for each correct item. The child was given 2 practice items.

3. Oddity task.

In this experimental task, the child was to listen to a series of three words presented in audiotape and to identify the "odd one out": the word that did not share a common sound component with the other three words. There was a total of 18 items. Six items required the child to identify the difference between the sound /sh/ and /s/, /f/ (e.g., shat, sham, san), and 6 items the difference between the sound /th/ and /z/, /v/ (e.g., thofe, thome, voze). The other 6 items were a set of control sounds common to both language groups (see Appendix F). One point was given for each correct item. There were 3 practice items.

4. Phoneme deletion task.

Among commonly used phonological awareness measures, including segmentation, blending, rhyming and oddity tasks, phoneme deletion has been found to be the most difficult for young children (e.g., Stanovich, et al., 1984). According to Yopp (1988), there are two factors on which most phonemic awareness tasks load: simple phonemic awareness and compound phonemic awareness. Simple phonemic tests require one operation (e.g., segment, blend, or isolate a given sound) and then a response, whereas compound phonemic awareness
require that the subjects perform an operation (specifically, isolate a given sound) and then hold the resulting sound in memory while performing another operation. Phoneme deletion task has the highest loading on the second factor, i.e., compound phonemic awareness. The subject recalls the remaining sounds and then blends them.

The task used in the present study was modeled after the Auditory Analysis Test (Rosner & Simon, 1971) (see Appendix G). Only high frequency words were used for the initial stimuli and target responses (e.g., "say leg... now say it again, but don't say /l/") in order to minimize the effect of lexical knowledge. There was a total of 20 items consisting of 3 sections of progressive difficulty. In the first section (4 items) the child was asked to delete one syllable from the spoken word (e.g., Say baseball, now say it without /base/). The second section (6 items) included deletion of initial or final single phonemes in one-syllable words (e.g., Say hand, now say it without the /h/). The third section (10 items) included deletion of single phonemes in an initial or final consonant cluster (CCVC or CVCC structure) in a word (e.g., Say stop, now say it without /s/, say left, now say it without /f/). The scoring was one point per correct item. There were 2 practice items.

5. Phonological working memory.

A large body of recent research has established the connection between phonological working memory and acquisition of vocabulary knowledge (e.g., Gathercole & Baddeley, 1989; Gathercole & Adams, 1993, 1994; Gathercole, et al., 1997). Pseudoword repetition task is widely considered to be one of the most
sensitive measures of phonological working memory, and used by Service (1992; see also Service & Kohonen, 1995) to predict vocabulary growth in L2. A shortened Pseudoword Repetition task (Gathercole, et al., 1994, see Appendix H) was used to assess children’s ability to perceive and repeat phoneme strings. Twenty-five pseudowords which consisted of phonologically unfamiliar sequences, and ranged in length from one to five syllables were presented on audiotape to each child. After hearing each item, the child was asked to repeat it verbatim and the responses was recorded as correct or incorrect by the experimenter. There were 3 practice items.

Vocabulary Measures

The Peabody Picture Vocabulary Test-III (PPVT-III) (Dunn & Dunn, 1997) was used as a measure of receptive vocabulary. The child was asked to point to the picture corresponding to the vocabulary word given. This measure was used to control for the effect of language proficiency. One point was given for each correct item.

Non-verbal Ability Test

The Matrix Analogy Test (MAT: Expanded form, Naglieri, 1985) was used to assess children’s non-verbal ability as a control variable when considering the relationship between spelling, decoding and phonological processing skills. The test had 64 abstract designs of the standard progressive matrix type. The child was shown a picture with a missing piece in it, and asked to choose one from five
options to fit into the missing piece. The child was allowed to either point or to say aloud the number of his or her answer.

Please note that at the beginning of the study, except those standardized tests (e.g., PPVT, MAT, and WRAT reading), some tasks were designed to examine the effects of different contrastive features of L1 on L2 learning (e.g., specific phonemes, “sh” and “th”, consonant clusters “st” and “sp”). However due to time constraints, we later decided to focus on the two contrastive phonemes, that is, “sh” and “th” for the analyses in the present study.

Procedures.

Most of the above measures were administered at each of the four testing times during the two-year period. However, pseudoword spelling and confrontation pseudoword spelling tasks was only administered at Time 3 (fall in grade 2) due to time constraints. PIAT-III spelling subtest was administered at Time 2 and Time 4. All testing was done on an individual basis by trained graduate students. The measures included in the present study were administered as part of four -five batteries, with the other measures related to the larger project designed to explore the development of various indices of ESL children’s oral language and literacy skills. These four to five testing batteries were administered randomly during four to five separate sessions. However, the word recognition task of to-be spelled words was always administered in a session following the one where these words were spelled. Each session lasted about 30 to 40 minutes.
It is important to note that in order to avoid bias associated with using norms standardized on L1 populations, raw scores of standardized tests (e.g., WRAT-R, Word Attack, Spelling selection) were not converted to percentiles or standard scores. Instead all analyses, for both standardized and experimental tasks, were based on raw scores. The use of raw scores also made it possible to note development over time.

Table 2.

Distribution of the Measures at 4 Testing Times

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
<th>Time 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spelling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real word</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pseudoword</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Confrontation pseudoword</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Spelling selection (PIAT-R)</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Phonological Processing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory discrimination</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rhyme selection</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Oddity</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Phoneme deletion</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Phonological working memory</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The spelled words</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>WRAT word recognition</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pseudoword decoding</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Vocabulary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT-III</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Non-verbal Ability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matrix analogies test</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
CHAPTER 4: THE DEVELOPMENT OF SPELLING IN CHINESE ESL CHILDREN: RESULTS AND DISCUSSION

In this chapter, the effects of language group as well as time on children's performance on each of the spelling tasks will be first examined through analyses of variance. The developmental qualitative changes in children's spelling in English-as-L1 and Chinese ESL children across times will be then examined. Finally, the spelling error pattern on two specific phonological/orthographic structures in the real word spelling task, that is, *sh, th* will be analyzed. In the following chapter, results concerning the relationship between spelling, reading, and phonological processing skills in English-as-L1 and Chinese ESL children across times will be presented.

The summary of statistics of the spelling measures at 4 times by L1 and Chinese ESL children from Grade 1 to Grade 2 is shown in Table 3. In order to control for Type I error, we set the α level at .01 for each of the following analyses.

**Real Word Spelling**

A repeated measures ANOVA was conducted on the real word spelling task, with the between-subject variable being the language group (L1 vs. ESL), and the

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3 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 over two standard deviations. The data of this child were not included in the subsequent analyses.
within-subject variable being the testing time (Time 1-4). Results showed that there was no significant main effect for language group, F (1, 55) = 1.68, p > .20. As expected, there was a significant effect for time, F (3, 53) = 145.78, p < .001, that is, children improved their performance across the 4 testing times. The interaction of time and language group was also found significant, F (3, 53) = 5.69, p < .005. Post-hoc t test showed that Chinese ESL children improved significantly their spelling performance from T1 to T2, from T2 to T3, and from T3 to T4, all ps < .001. Whereas L1 children did not improve their performance significantly from T2 to T3, t (31) = 1.245, p > .2. However, their performance improved significantly from T1 to T2, and T3 to T4.

This finding is consistent with Holm and Dodd (1996) and Wade-Woolley and Siegel (1997), who report that Chinese ESL children did not perform differently from L1 children on real word spelling tasks. It suggests that ESL children could spell high frequency words as well as English speaking children. The present study clearly shows that they also improve their performance at a similar pace to that of L1 children. According to Besner and Smith (1992), familiar and frequent words can be read and spelled by a direct, non-phonological route called addressed phonology, whereas reading and spelling unknown or low-frequency words requires a process called assembled phonology, that is, indirect word recognition via grapheme-phoneme conversion. It seems that the addressed phonology route in these ESL children have is not affected by their language
status. Whether the assembled phonology route is affected or not will be tested in the following section.

Table 3.

Means (and SDs) of the Spelling Measures across Time 1 to Time 4 by L1 and ESL children

<table>
<thead>
<tr>
<th>Time</th>
<th>Measure</th>
<th>L1</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Real word spelling %</td>
<td>17.19(15.84)</td>
<td>16.43(20.73)</td>
</tr>
<tr>
<td></td>
<td>Spelling selection %</td>
<td>33.71(8.91)</td>
<td>40.21(13.37)</td>
</tr>
<tr>
<td>2</td>
<td>Real word spelling %</td>
<td>42.88(25.10)</td>
<td>41.73(33.74)</td>
</tr>
<tr>
<td></td>
<td>Spelling selection %</td>
<td>33.71(8.91)</td>
<td>40.21(13.37)</td>
</tr>
<tr>
<td>3</td>
<td>Real word spelling %</td>
<td>45.12(25.73)</td>
<td>60.42(32.51)</td>
</tr>
<tr>
<td></td>
<td>Pseudoword spelling %</td>
<td>42.38(27.35)</td>
<td>19.79(21.41)</td>
</tr>
<tr>
<td></td>
<td>Conf.pseudo.spelling %</td>
<td>44.53(25.10)</td>
<td>79.72(16.48)</td>
</tr>
<tr>
<td>4</td>
<td>Real word spelling %</td>
<td>72.54(25.48)</td>
<td>81.47(21.68)</td>
</tr>
<tr>
<td></td>
<td>Spelling selection %</td>
<td>43.86(9.70)</td>
<td>57.55(14.71)</td>
</tr>
</tbody>
</table>

Note. The number of items in real word spelling is 16; spelling selection is 100; pseudoword spelling is 16; and confrontation pseudoword spelling is 12.

Time 1: N for L1 = 36, ESL = 35
Time 2: N for L1 = 36, ESL = 34
Time 3: N for L1 = 32, ESL = 30
Time 4: N for L1 = 28, ESL = 29

Pseudoword Spelling: The Effect of Lexicality

In order to test whether pseudowords are more difficult for children to spell than real words and whether L1 and Chinese ESL children differ in spelling
performance when they have to spell unfamiliar pseudowords, a 2 x 2 ANOVA was conducted at Time 3 with language group being the between-subjects variable (L1 vs. ESL) and lexicality being the within-subject variable (real vs. pseudoword). Main effects in the expected direction were found for lexicality, $F(1, 60) = 60.15, p < .001$, but not for language group, $F(1, 60) = .34, p > .5$. On the whole, regardless of language group, children produced more accurate spelling on real words than pseudowords. The interaction between language group and lexicality was also significant, $F(1, 60) = 45.93, p < .001$ (see Figure 2). Post-hoc $t$-test showed that the L1 means on real and pseudoword spelling did not differ from each other, but ESL children spelled real words significantly more accurately than pseudowords, $t(31) = .79, p > .44$ for L1, $t(29) = 9.17, p < .001$ for ESL children. The reason why ESL children did so poorly on the pseudoword spelling task may be that the assembled phonology route is affected in these children, that is, they had difficulty in applying rules to convert phonemes to graphemes. Instead, they may use a "global strategy" acquiring English spelling (Holm & Dodd, 1996), and they may have better visual-orthographic processing skills as we show later with the confrontational spelling task.
Confrontation Pseudoword Spelling: The Effect Of Visual-Orthographic Processing

The means and standard deviations of correct responses on 2 groups of items in the confrontation pseudoword spelling task are listed in Table 4. In order to examine the effect of orthographic legitimacy on children’s pseudoword spelling, a repeated measure ANOVA was conducted, with the between subject factor being language group (L1 vs. ESL), and the within-subject factor being orthographic legitimacy of the pseudowords (legitimate vs. illegitimate). Results showed that there was a significant language effect, $F(1, 59) = 77.03, p < .001$. Overall, Chinese children performed significantly better than L1 children on both orthographically legitimate and illegitimate pseudowords. The effect of legitimacy was significant as well, $F(1, 59) = 77.03, p < .001$. Children performed better on
legitimate pseudowords than on illegitimate ones. Results also showed that there was a significant interaction between legitimacy and language group, \( F(1, 59) = 12.06, p < .002 \) (see also Figure 3). Post-hoc \( t \)-test showed that the difference between accuracy scores in spelling legitimate and illegitimate items in L1 was much greater than that in ESL children, \( t(59) = 3.47, p < .002 \) as shown by the mean number of correct responses in Table 4.

Table 4.
**Means (and SDs) of the Effect of Orthographic Legitimacy on L1 and ESL Pseudoword Spelling**

<table>
<thead>
<tr>
<th></th>
<th>L1 (N = 32)</th>
<th>ESL (N = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legitimate</strong></td>
<td>3.91</td>
<td>5.33</td>
</tr>
<tr>
<td></td>
<td>(1.61)</td>
<td>(0.88)</td>
</tr>
<tr>
<td><strong>Illegitimate</strong></td>
<td>1.44</td>
<td>4.24</td>
</tr>
<tr>
<td></td>
<td>(1.76)</td>
<td>(1.60)</td>
</tr>
</tbody>
</table>

*: The score ranged from 0-6.

This finding is consistent with Haynes and Carr (1990)'s results with Chinese adult ESL readers, as well as Koda's (1987; 1989) results with Japanese adults. Those studies suggested strong orthographic processing skills in logographic readers (i.e., Chinese or Japanese), and that phonological inaccessibility caused by orthographic illegitimacy has fewer negative effects on them. These findings are replicated in the present study with young ESL children whose Chinese reading experience is much more limited than that of adult ESL
readers. As we have mentioned in the previous chapter, these children are reported to attend weekend Chinese classes. Some of them also participate after school hours or on weekends in special private tutoring classes in Chinese on some particular school subjects such as math. Therefore, these children have been obtaining certain amount of instruction on Chinese reading and writing. It seems that even with limited exposure to Chinese literacy instruction, the effect of orthographic legitimacy is weakened among young Chinese ESL readers.4

Figure 3. Spelling accuracy in confrontational pseudoword task at Time 3

4 Note that an ANCOVA was further conducted on the effect of orthographic legitimacy on children's spelling by controlling for non-verbal ability (i.e., MAT score in this study), the significant better performance by Chinese ESL children still held.
To explore the above interpretation further an additional analysis was carried out. The orthographically legitimate items were common to the pseudoword spelling task (i.e., audio presentation) and the pseudoword confrontation spelling task (i.e, visual presentation). The means and standard Table 5.

Means (and SDs) of Correct Spelling of L1 and ESL Children on Pseudowords Presented Orally or Visually

<table>
<thead>
<tr>
<th></th>
<th>L1 (N = 32)</th>
<th>ESL (N = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio-spelling*</td>
<td>2.94</td>
<td>1.47</td>
</tr>
<tr>
<td>(1.74)</td>
<td>(1.63)</td>
<td></td>
</tr>
<tr>
<td>Visual-spelling*</td>
<td>3.91</td>
<td>5.33</td>
</tr>
<tr>
<td>(1.61)</td>
<td>(0.88)</td>
<td></td>
</tr>
</tbody>
</table>

*: The score ranged from 0-6.

deviations of correct spelling of these items for each language group in each task are shown in Table 5. A repeated measures ANOVA was conducted to examine differences between the two groups on these common times. Results showed that the effect of spelling mode (whether it is via audio presentation or video presentation) was significant, $F (1, 60) = 120.39, p < .0001$. Children spelled significantly more accurately visually presented stimuli than audio presented stimuli. The effect of language group was not significant, $F (1, 60) = .01, p > .9$. However, the interaction between language group and spelling mode was significant, $F (1, 60) = 43.24, p < .0001$, and post-hoc $t$-test revealed that the
difference between the correct spellings on these 2 tasks was significantly larger for Chinese ESL children than for L1 children, \( t (60) = -6.58, p < .001 \) (see also Figure 4).

It indicated that Chinese ESL children benefit more from visual presentation of the pseudowords compared to audio presentation than do L1 children. In other words, this result corroborates the pattern noted for confrontational spelling and the effects of lexicality discussed earlier.

![Figure 4: Spelling accuracy in audio- and visually-presented conditions at T3](image)

**Figure 4.** Spelling accuracy in audio- and visually-presented conditions at T3

**Spelling Selection: The Effect of Orthographic Processing**

A repeated measure ANOVA revealed a main effect for time on spelling selection task (PIAT-R) from Time 2 to Time 4, \( F (1, 55) = 110.59, p < .001 \), and a significant effect of language group, \( F (1, 55) = 12.29, p < .002 \). As was the case with
the confrontational pseudoword spelling task, Chinese children performed better than L1 children on this task, pointing to stronger orthographic processing skills. There was also a significant interaction effect between time and language group, \( F(1, 55) = 6.94, p < .02 \). Post-hoc t-test indicated that both L1 and ESL children increased significantly correct spelling selections from T2 to T4, both \( ps < .001 \), yet Chinese children gained more than L1 children. This finding might also result from the fact that the words in the selection task were all real words, where the addressed phonology route was required to read and spell. Chinese ESL children’s ability to recognize the correct spelling seems to be superior to that of L1 children.

The above analyses were based on the total accuracy scores of children’s performance on each of the four spelling tasks. In these analyses we examined the effect of language group and time on children’s spelling performance. Strong effects of lexicality and orthographic processing were revealed for Children ESL children, whereas these effects failed to be shown for L1 children. Another objective of this study was to investigate in depth the Chinese ESL children’s performance in spelling words containing a contrastive phonological and orthographic element, as well as in spelling those containing no such structures in comparison with L1 children. In the following section we will focus on the effect of language on qualitative changes in real word spelling task in L1 and Chinese ESL children.
Developmental Spelling Levels of L1 and Chinese ESL Children

Figure 5 provides a graphic summary of the development of the 16 English spelling words from Time 1 to Time 4. Spelling level means were based on Liberman, et al. (1985), and Mann, et al. (1987)'s quality point system for determining developmental level of spelling in children at kindergarten and first grade (see Method). The mean scores for each word were arranged in an ascending order, based on L1 children’s performance at Time 1. Several general observations can be made from an examination of this figure. First, it is clear that in both language groups approximations to standard spelling do not evolve simultaneously for all words. For example, the word “cats” and “dogs” are among the easiest to spell across the 4 times. Second, the developmental trajectories of the spelling words for L1 and Chinese ESL children are generally similar. By Time 4, at the end of grade 2, the mean scores of most words were above 4 points, that is, all the phonemes in words were represented in the word spellings in both language groups. For example, the word “happy” reached highest score of “5” for both language groups at Time 4. However, the word “peeked” remained among the hardest words to spell at Time 3 and Time 4. It is not surprising given that the complex morphological structure, that is, past tense “-ed” is involved in the word. Even when all the phonemes in the word are represented at Time 4, there still exists the difficulty with correctly spelling "ed" in "peeked". The problem for young spellers here is to overcome phonological information (the "ed" in “peeked” sounds like /t/), and combine it with morphological and orthographic knowledge.
Figure 5. Words ranked for developmental spelling level for L1 and Chinese ESL children at 4 times
Third, by examining the most difficult words in the list, it was found that for L1 children the word "peeked" continued to have the lowest score at Time 2, 3, and 4, though at Time 1 the word "thick" was the lowest. For Chinese ESL children, however, "thick" was at the lowest spelling level at Time 1 and 2, both below 2 points (recall that 2 points were given to a spelling which has the initial consonant plus other segments). That is, Chinese ESL children did not spell correctly the first phoneme /θ/ at Time 1 and 2. It remained as the most difficult one along with "peeked" even at Time 3 and 4. Therefore, "thick" seems to be the most difficult word for Chinese ESL children in this list of spelling words, and this was the case till Time 4. The difficulty in spelling "thick" for Chinese children lies in the fact that it contains 2 components ("th" and "ck") which impose phonological or orthographic challenge for younger spellers. Although L1 children also experienced difficulty in spelling "thick" in Time 1, their performance improved considerably from Time 2 on. We also examined another word of interest, "ship". At Time 1 both L1 and ESL children's mean scores in spelling "ship" was below 2 (1.67 for L1, 1.06 for ESL children), with the 2 language groups having problems with spelling "sh" correctly (see the next section, Table 6). However, from Time 2 on, children in both groups improved quickly in spelling this elements.

The observation that some words in the list which contain specific phonological and orthographic elements such as "sh" and "th" were spelled at a very low level among Chinese ESL children led us to carry out a more fine-grained error analysis in a search for the source of these difficulties.
Error Patterns in L1 and Chinese ESL Children's Spelling

As noted in the introduction, when learning to spell and read in L2, a possible source of difficulty may be the need to form new phonological representation. This requirement may compound task complexity in that the child needs to learn to form new phonological distinctions as well as to master various orthographic and morphological rules. This challenge is evident when participants are Chinese children learning English as L2, because certain phonemes such as "sh" and "th" are not available in their first language, Cantonese. As those language-specific processing hypotheses of L2 acquisition would suggest, the transfer of L1 phonological representations exerts a powerful influence on learning L2. The comparison of L1 and L2 is useful in predicting the areas of difficulty. Thus, the absence of these 2 phonemes in L1 phonology for Chinese ESL children would cause specific delays in learning to spell these phonemes in English as L2 learners.

In this section we focus on 3 words from the real word spelling task which contain the new phonemes "sh" or "th", both represented orthographically with digraphs, and compare children's performance in spelling "th" with that in spelling another digraph "ck", which is assumed to present orthographic but no phonological challenge to Chinese ESL children. The analysis is based on error Frequencies and error patterns made by L1 and Chinese ESL children on these linguistic-orthographic units.
Error Frequency and Error Types in Spelling the "sh" in SHIP.

The upper part of Table 6 shows the frequency of errors in spelling the "sh" phoneme in "ship" by L1 and Chinese ESL children across 4 times. The number of children who made errors on the "sh" phoneme was not significantly different between L1 and Chinese ESL children from Time 1 to Time 4, $\chi^2 (1, N=70) = 1.30, p > .2$ for Time 1; $\chi^2 (1, N=70) = .10, p > .8$ for Time 2; $\chi^2 (1, N=62) = .56, p > .5$ for Time 3; and $\chi^2 (1, N=57) = .125, p > .7$ for Time 4, respectively. Nonparametric analysis (Cochran's Q test) indicated that error frequency on the "sh" phoneme for both L1 and ESL children decreased significantly from Time 1 to Time 4, Q (3, N=28) = 33.52, $p < .001$ for L1, Q (3, N=29) = 39.89, $p < .001$ for Chinese ESL children.

Table 6.
Distribution of Children by Language Group and Performance in Spelling "sh" in SHIP at 4 Times

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Error frequency:</strong></td>
<td>L1</td>
<td>ESL</td>
<td>L1</td>
<td>ESL</td>
</tr>
<tr>
<td>incorrect</td>
<td>25</td>
<td>29</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>correct</td>
<td>10</td>
<td>6</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>total n</td>
<td>35</td>
<td>35</td>
<td>36</td>
<td>34</td>
</tr>
<tr>
<td><strong>Error types:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>phon.o.error &quot;s&quot;</td>
<td>8</td>
<td>19</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>&quot;f&quot;</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ortho.error &quot;h&quot;</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>&quot;hs&quot;</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2 letters(e.g., &quot;ch&quot;)</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>no letter</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>correct</td>
<td>10</td>
<td>6</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>total n</td>
<td>35</td>
<td>35</td>
<td>36</td>
<td>34</td>
</tr>
</tbody>
</table>
One reason that Chinese ESL children were as good as L1 children in spelling accuracy on "sh" across the time may be due to the fact that the "sh" phoneme is acquired in speech at an early stage, that is, by age 5 in English-as-L1 children (Menyuk, 1971), and that /sh/ has a close neighbor in Chinese (as the /sh/ in Shanghai). That is, /sh/ presents very little phonological challenge though it does present an orthographic challenge in English because its spelling in English involves a digraph rather than a single letter. This orthographic element appeared to be equally challenging for L1 and ESL children alike.

Although the error frequency on spelling "sh" did not differ significantly between the 2 language groups, it would be interesting to see whether they differ in terms of error types which would also be able to test the effect of L1. The lower part of Table 6 shows the frequency of error types in the 2 groups of children. The errors in spelling "sh" were coded into 3 categories: (1) imprecise phonological representation: "s" for "sh", or "f" for "sh"; (2) orthographic errors indicating partial orthographic knowledge: "h" for "sh", letter reversal (i.e., "hs"), another digraph (e.g., "ch"); and (3) no letter to represent the "sh" phoneme. By inspecting Table 6 we find that the major error types for L1 and Chinese ESL children are different at Time 1. About 71% (25 out of 35) of the ESL children had imprecise phonological representation, and only 11% (4 out of 35) committed orthographic errors. Whereas, the number of L1 children who made phonological or orthographic errors was relatively equivalent, 29% for phonological errors and 31% for orthographic errors. A $\chi^2$ test indicated that Chinese ESL children made
significantly more phonological errors than L1 children at Time 1, $\chi^2(3, N=70) = 11.94, p < .01$. From Time 2 on, however, the difference between the 2 language groups was not significant.

The above results clearly show that even though Chinese ESL children did not make more errors in spelling "sh" than L1 children, the nature of their errors was different at T1. They made significantly more imprecise phonological errors as predicted by the negative transfer hypothesis. In the case of "s" for "sh", the explanation could be that Chinese ESL children might borrow the closest phoneme from L1 to map the digraph. Whereas in the case of "f" for "sh", it could be that because there is no easy mapping for the digraph, some phoneme from L1 might intrude (Perfetti, 1999, personal communication). However, it is worth noting that the L1 negative effect only existed at the beginning of Grade 1, reflecting the effect of school instruction and language development on children's second language learning.

**Error Frequency and Error Types in Spelling the "th" Phoneme in TEETH.**

Table 7 shows the frequency of errors and error types in spelling "th" in TEETH by L1 and ESL children over the 4 Times. Compared to "sh", "th" is a relatively harder phoneme to acquire for normal L1 children till age 6 (Menyuk, 1971). As noted earlier, /θ/ does not exist in Chinese, and our results showed that significantly more Chinese ESL children made errors in spelling "th" phoneme in "teeth" than L1 children at Time 1 and Time 2, $\chi^2(1, N=70) = 9.03, p < .01; \chi^2(1,
$N=70)$ = 23.97, $p < .001$, respectively. However, at Time 3 and 4, the groups were not significantly different from each other, $\chi^2 (1, N=62) = .01, p > .9$; $\chi^2 (1, N=57) = .07, p > .8$, respectively. Nonparametric analysis (Cochran's) Q test indicated that the number of errors for both L1 and ESL children decreased significantly across the 4 times, $Q (3, N=28) = 34.00, p < .001$ for L1, and $Q (3, N=29) = 51.41, p < .001$ for ESL children.

As with the case of "sh" in SHIP, children's errors in spelling "th" in "teeth" were coded into the following 3 categories: (1) imprecise phonological representation: "s" or "z" for "th", "f" for "th", "t" for "th"; (2) orthographic errors indicating partial orthographic knowledge: "h" for "th", letter reversal (i.e., "ht"), another digraph (e.g., "ch"); and (3) the "th" phoneme not represented at all.

Inspection of Table 7 reveals that at Time 1 L1 children made errors on "th" relatively randomly among the 7 categories, whereas a large number of Chinese children (63%, 22 out of 35) did not use any letter to represent "th" at Time 1. At Time 2 more than half of L1 children (69%, 25 out of 35) spelled /ð/ correctly, whereas about 56% (19 out of 34) of the Chinese ESL children continued to represent this phoneme inaccurately, that is, "th" represented as "s", "z", or "f", or "t". These imprecise phonological representations could be explained by the negative transfer effect from L1, just as those with "sh". In addition, 32% (11 out of 34) still did not use any letter to represent "th". A $\chi^2$ analysis showed that significantly more Chinese ESL children had difficulty in representing /ð/ at Time 1, $\chi^2 (3, N=70) = 20.68, p < .001$. At Time 2, more Chinese ESL children than L1
children made phonological errors for the spelling of "th", and more Chinese ESL children than L1 children still had difficulty in representing "th" with any letter, \( \chi^2 (3, N=70) = 43.19, p < .001 \). From Time 3 on, however, the difference between the 2 language groups of children was not significant.

Table 7.

**Frequency Distribution by Language Group and Performance in Spelling “th” in TEETH at 4 Times**

<table>
<thead>
<tr>
<th>Error frequency:</th>
<th>T1 L1</th>
<th>T1 ESL</th>
<th>T2 L1</th>
<th>T2 ESL</th>
<th>T3 L1</th>
<th>T3 ESL</th>
<th>T4 L1</th>
<th>T4 ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>incorrect</td>
<td>27</td>
<td>35</td>
<td>11</td>
<td>30</td>
<td>11</td>
<td>10</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>correct</td>
<td>8</td>
<td>0</td>
<td>25</td>
<td>4</td>
<td>21</td>
<td>20</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>total n</td>
<td>35</td>
<td>35</td>
<td>36</td>
<td>34</td>
<td>32</td>
<td>30</td>
<td>28</td>
<td>29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Error types:</th>
<th>T1 L1</th>
<th>T1 ESL</th>
<th>T2 L1</th>
<th>T2 ESL</th>
<th>T3 L1</th>
<th>T3 ESL</th>
<th>T4 L1</th>
<th>T4 ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>phono. error</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>16</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>&quot;s&quot;or &quot;z&quot;</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>&quot;t&quot;</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ortho. error</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>&quot;ht&quot;</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2 letters(e.g., &quot;ch&quot;)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>no letter</td>
<td>8</td>
<td>22</td>
<td>0</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>correct</td>
<td>8</td>
<td>0</td>
<td>25</td>
<td>4</td>
<td>21</td>
<td>20</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>total n</td>
<td>35</td>
<td>35</td>
<td>36</td>
<td>34</td>
<td>32</td>
<td>30</td>
<td>27</td>
<td>29</td>
</tr>
</tbody>
</table>

**Error Analysis on the Phonemes “th” and “ck” in THICK.**

The word "thick" offers an excellent opportunity to test the hypothesis that Chinese ESL children have specific difficulty in representing the phoneme “th” due to the negative transfer from their L1 phonology and not merely difficulty at the
orthographic level. It contains 2 digraphs, "th" and "ck", which impose great challenge for young spellers, especially when both appear in one word. In order to spell "ck" in "thick" correctly, children are required to access certain orthographic knowledge and evaluate the possible graphemic candidates for the sound /k/, for example, c, k, ck, or even ch, whereas spelling "th" in "thick" requires a coordination of orthographic and phonological decisions, with decisions about the precise nature of a more fuzzy representation of a newly acquired phoneme. Yet, /θ/ is less complex orthographically than "ck" since there is only one orthographic candidate for the sound /θ/ (provided that it is perceived accurately). However, since the sound /θ/ is not available in Chinese children's first language, and given what we found in the error patterns the Chinese ESL children made in spelling "th" in "teeth", we hypothesize that both "th" and "ck" in "thick" would impose difficulty for these ESL children. On the other hand, we expected that the L1 children's performance would be more accurate for "th" than "ck".

Children's spelling performance was coded into the following 4 categories: (1) no error on both 2 elements; (2) error on "th" only; (3) error on "ck" only; and (4) error on both "th" and "ck". Figure 6 describes the percent of children in the 2 language groups across the 4 categories. As can be seen, the number of children who made both "th" and "ck" errors dropped from Time 1 to Time 4 for both language groups. In other words, the number of children who made no errors in

---

5 Note that this is confounded with position of the two phonemes in the word.
spelling both "th" and "ck" increased over the time. However, it is more interesting to compare the percent of children from the 2 language groups who made spelling errors on "th" only or "ck" only. Consistently, more L1 children made errors on "ck" than on "th" across the 4 Times. However, the percent of Chinese ESL children in these 2 types of errors was similar to each other. This pattern suggests that L1 children experienced more difficulty in spelling "ck" than "th", whereas Chinese ESL children experienced difficulty in spelling both elements, as the new phonological representation of sound /θ/ is required for these children. By Time 4, however, Chinese ESL children's error pattern for "th" and "ck" was close to that noted for L1 children, that is, over time the difficulty in spelling "th" and "ck" was overcome by ESL children.
Figure 6. Percent of children making errors on 2 phonemes of "THICK" at 4 times by L1 and Chinese ESL children.
Error Frequency in Spelling "sh" and "th" in Pseudoword Spelling at Time 3.

The results of the error analyses involving real word spelling revealed that in terms of error frequency Chinese ESL children did not differ from L1 children on "sh" beginning at Time 1, whereas they differ from L1 children on "th" at Time 1 and 2, but not at Time 3 and 4. It would be interesting to examine how the 2 groups of children perform on "sh" and "th" in pseudoword spelling task. This examination allows us to bypass the lexicality effect which would favor the ESL children as shown in the previous section in this chapter. Means and standard deviations of error frequency on "sh" and "th" phonemes on the pseudoword spelling task* at Time 3 are listed in Table 8. Results of a repeated measures ANOVA, with the between-subject variable being language group, and within-subject variable being the 2 phonemes, showed that there was a significant phoneme effect, $F(1, 60) = 20.20, p < .001$. Children produced significantly fewer spelling mistakes on "sh" than "th". The group effect was not significant, however, $F(1, 60) = 3.22, p > .05$. The interaction between language and phonemes was not significant, either, $F(1, 60) = 2.64, p > .1$. Children in general had more difficulty in spelling "th" than "sh", but just as with real word spelling task, from Time 3 on, both language groups did not differ from each other in the performance of spelling "sh" and "th" in pseudowords.

* Two consonant structures were also tested in this task, sp, st. In this thesis we focus on 2 phonemes sh and th, therefore, the results on the 2 clusters are not presented here.
Table 8.
Means (and SDs) of Error Frequency on “sh” and “th” in Pseudoword Spelling Task at Time 3

<table>
<thead>
<tr>
<th></th>
<th>L1 (N=32)</th>
<th>ESL (N=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sh*</td>
<td>1.16 (1.57)</td>
<td>1.47 (1.59)</td>
</tr>
<tr>
<td>th*</td>
<td>1.69 (1.49)</td>
<td>2.60 (1.45)</td>
</tr>
</tbody>
</table>

*: The score ranged from 0-4.

Summary

In this chapter we investigated different aspects of spelling performance in Chinese ESL children and L1 children. The results clearly showed that just as L1 children, ESL children improved their performance significantly during the first 2 years of school instruction on a variety of spelling tasks varying in task demands. The effect of lexicality was significant in that Chinese ESL children showed poorer performance in spelling pseudowords than in spelling real words, whereas L1 children’s performance in spelling pseudowords did not differ from that in spelling real words. The effect of visual-orthographic processing was strong in that Chinese ESL children outperformed L1 children in the confrontation spelling task. Moreover, while L1 children did poorly on illegitimate, unpronounceable letter strings compared to legitimate, pronounceable pseudowords, the difference in spelling performance on these two groups of items for Chinese ESL children was
significantly smaller than that for L1 children. Furthermore, Chinese ESL children benefited more from the visual presentation than the audio presentation of the same pseudowords. The evidence of a strong orthographic processing skills also appears in the spelling selection task. These results indicate that the L1 and ESL children may exploit a different route when learning to spell. The Chinese ESL children were clearly strong at the visual-orthographic processing route, whereas the L1 children were strong at the assembled phonological processing route.

The results from developmental trend analyses of each word in the real word spelling list suggest a similar developmental trajectory of spelling levels across the 4 Times for L1 and ESL children. At the same time, especially low spelling level scores in Chinese ESL children reflected difficulty in spelling certain phonemes that are absent in their L1 phonology. Error analyses focusing on the two L1-specific phonemes “sh” and “th” showed evidence of interference of L1 on L2. Chinese ESL children made significantly more phonological errors which reflect imprecise phonological representation of these 2 phonemes than L1 children. The word, THICK, offers a best example for the negative transfer. Chinese ESL children showed difficulty in spelling both “th” and “ck” digraphs, whereas for L1 children there was difficulty only in spelling “ck”. This result

It is important to note that the results from the error analyses in this thesis were based on between-group comparisons. In order to test the hypothesis sufficiently that ESL children’s difficulty in spelling contrastive phonemes was due to the absence of these phonemes in the L1 phonology, it is necessary in future research to conduct within-group comparisons. Children’s spelling performance on a set of items with the phonemes that are absent in the L1 vs. another set of items with the phonemes that are present in the L1 will be compared within the language group. See also the “Limitation and Future Research” section for further discussion.
suggests that Chinese ESL children have difficulty in representing the phoneme “th” due to the negative transfer from their L1 phonology, and not merely difficulty at the orthographic level. It is also worth noting that the difficulty with spelling the contrastive phonemes “sh” and “th” found in ESL children’s spelling did not persist across time. By the time they were in grade 2, the performance of ESL children was very close to L1 children.
CHAPTER 5: THE RELATIONSHIP BETWEEN SPELLING, READING, AND PHONOLOGICAL PROCESSING IN CHINESE ESL CHILDREN: RESULTS AND DISCUSSION

In Chapter 4 results pertaining to developmental aspects of transfer in L1 and L2 spelling were addressed. This Chapter focuses on aspects of individual differences. In particular, we explore the relationship between spelling, reading, and phonological processing in Chinese ESL children and the contribution of underlying cognitive factors. The Chapter first examines the effect of time and language on various reading and phonological tasks as well as vocabulary and non-verbal ability tests. Second, correlations between spelling, reading, and phonological processing skills in the two language groups will be presented. Third, the contribution of underlying cognitive processes to spelling after controlling for vocabulary as well as non-verbal ability will be explored. Finally, the role of language transfer on phonologically processing two digraphs "sh" and "th" will be examined.

The Effect of Language Group and Time on Word Reading

The means and standard deviations for the reading measures are shown in Table 9. Separate repeated measure ANOVAs were conducted with the between-subject variable being the language group, and the within-subject variable being the testing time. Results revealed that language had no significant effect on the spelled word reading accuracy (i.e., the words which appeared in the real word
spelling task) or on pseudoword decoding, $F(1, 54) = 1.84, p > .1$; $F(1, 55) = .41, p > .5$. That is, Chinese ESL and L1 children did not differ on these 2 tasks. However, language had a significant effect on WRAT reading; Chinese children performed better than L1 children, $F(1, 54) = 4.90, p < .05$. This somewhat surprising finding may be explained by the argument that ESL children's addressed phonology route is not affected and may surpass L1 children. It allows these ESL children to rely on other strategies such as strong visual orthographic processing skill when they read and spell real words. This finding is consistent with the results noted in the real word spelling task, where it was noted that Chinese ESL children and L1 children did not differ in their performance. Likewise, Chinese ESL children were better than L1 children in spelling selection task and confrontational spelling task.

Table 9.

Means (and SDs) of 3 Reading Measures at 4 Times by L1 and ESL Children

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>ESL</td>
<td>L1</td>
<td>ESL</td>
</tr>
<tr>
<td>The Spelled Words %</td>
<td>28.99 (28.20)</td>
<td>46.40 (30.29)</td>
<td>68.75 (28.39)</td>
<td>67.83 (32.54)</td>
</tr>
<tr>
<td>WRAT %</td>
<td>10.65 (9.13)</td>
<td>16.02 (10.67)</td>
<td>19.51 (10.77)</td>
<td>22.69 (11.78)</td>
</tr>
<tr>
<td>WA %</td>
<td>14.04 (16.70)</td>
<td>15.49 (18.75)</td>
<td>27.28 (20.23)</td>
<td>26.54 (22.25)</td>
</tr>
</tbody>
</table>

Note. WRAT = Wide Range Achievement Test; WA = Word Attack Subtest of the Woodcock Reading Mastery Test. The number of items in the spelled word reading is 16; WRAT is 42; WA is 45.
The results summarized in Table 9 show that time effect was significant for all the 3 reading measures: the spelled word reading, WRAT reading and pseudoword decoding, $F(2, 53) = 83.74, p < .001; F(3, 52) = 77.43, p < .001; F(3, 53) = 46.11, p < .001$, respectively. Consistent with the various spelling tasks, both groups of children improved their performance in word reading during the first 2 years of school instruction.

There was a significant interaction between time and language group for spelled word reading and pseudoword decoding, $F(2, 53) = 5.01, p < .02; F(3, 53) = 4.08, p < .02$, respectively. However, there was no significant interaction between language and time on WRAT reading, $F(3, 52) = .99, p > .4$. On WRAT reading, Chinese children were consistently better than L1 children across times. On spelled word reading, Chinese children were better than L1 children at Time 1, however, the 2 groups did not differ from each other from Time 2 on. Whereas on pseudoword decoding, L1 performed better than Chinese children at Time 1 and Time 2, at Time 3 and Time 4, Chinese children surpassed their L1 counterparts.

What is intriguing here is the result of no-difference between the 2 language groups in performance in pseudoword decoding task. This result does not correspond to the finding in pseudoword spelling task, where Chinese ESL children did more poorly than L1 children. It seems that spelling pseudowords imposes problem for Chinese ESL children, but not reading them. The reason, one may argue, is that the items in the pseudoword spelling task contain certain components (e.g., sh, th) which are expected to be difficult for ESL children. In
order to examine closely how exactly reading and spelling related to each other in
the L1 and ESL children, we used the data from the spelled word reading list (these
words were spelled by children in an earlier session) to compare how they read the
same words. The 3 words which contained “sh” and “th” in the real word spelling
task that were analyzed in term of error frequency in the previous chapter (i.e.,
SHIP, TEETH, and THICK) were coded in terms of accuracy in reading and
spelling. The distribution of children by language group in the 4 possible
categories of reading and spelling is listed in Table 10.

These data indicate that at Time 1, for all 3 words, the majority of L1
children fell into the category \textit{SR}. That is, they could not read them, nor spell
them accurately. By Time 4, the majority of L1 children fell into the category \textit{SR};
they could both read and spell them correctly, as did the ESL children. However, at
Time 1, for each of the 3 words more ESL children fell into the category \textit{SR},
namely, incorrect spelling but correct reading. At Time 2, similar results were
obtained for the word “teeth” and “thick”. At Time 4, there were still slightly more
ESL children who could read but not spell the word “teeth”. Otherwise, the
performance of the 2 language groups by Time 4 was rather similar. It seems that
at the beginning stages of learning to read and spell, there is consistency between
reading and spelling in L1 children, whereas for ESL children the difficulty was
primarily in spelling but not reading.
Table 10.
Distribution of Children by Language Group and Performance in the 4 Categories of Reading and Writing

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th></th>
<th>Time 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SR</td>
<td>SR</td>
<td>SR</td>
</tr>
<tr>
<td>SHIP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>27</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>ESL</td>
<td>17</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>TEETH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>28</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>ESL</td>
<td>20</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>THICK</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>L1</td>
<td>32</td>
<td>3</td>
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</tr>
<tr>
<td>ESL</td>
<td>22</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Note:
SR = incorrect spelling and incorrect reading
SR = incorrect spelling and correct reading
SR = correct spelling and incorrect reading
SR = correct spelling and correct reading

The Effect of Language Group and Time on Phonological Processing Skills

Means and standard deviations of all the 5 phonological tasks by language group over the 4 times are summarized in Table 11. Several repeated measures ANOVA showed that there was a significant effect of time for all of the tasks: auditory discrimination, rhyme selection, oddity task, phoneme deletion, and phonological working memory, $F(3, 50) = 12.71, p < .001; F(3, 52) = 21.74, p < .001; F(3, 50) = 16.86, p < .001; F(3, 52) = 16.22, p < .001; F(2, 52) = 7.25, p < .01$, respectively. Again it showed the consistent improvement of ESL children and L1 children on these tasks over the time. Importantly, this steady improvement is consistent across the various reading, spelling, and phonological processing tasks.
However, there was only a significant effect of language group on the auditory discrimination task, $F(1, 52) = 6.09, p < .05$. L1 children performed better than Chinese ESL children on this task. The effects of language for the other tasks were not significant, $F(1, 54) = .60, p > .4$ for rhyme selection, $F(1, 52) = .02, p > .0$ for oddity, $F(1, 54) = .26, p > .6$ for phoneme deletion, $F(1, 53) = 2.58, p < .1$ for phonological working memory.

With regard to interactions between time and language group, except on the oddity task, it was significant for auditory discrimination, rhyme, phoneme deletion and phonological working memory, all $ps < .01$. The interactions were mainly caused by the drop or no increase by L1 children’s performance at Time 3 for auditory discrimination, rhyme, and phoneme deletion tasks, as well the jump for ESL children on auditory discrimination at Time 3 (i.e., the beginning of grade 2). Whereas for phonological working memory task it was due to the difference between the 2 groups at the Time 1. The reason for the drop in L1 children’s performance at Time 3, however, remains uncertain. It might be the fact of natural regression in children’s language development (Karmiloff-Smith, 1992), i.e., the so-called U-shaped developmental curve. The drops of accuracy in performance also seem to be consistent across different types of reading and spelling tasks. However, it is intriguing that ESL children did not manifest these changes in L2 development. Another possible reason causing this kind of drop, one might argue, is a loss of some L1 subjects from Time 2 to Time 3, and that perhaps a large percentage of poorer children remained in the pool. A check of the data indicated
that there was no systematic loss of higher-functioning children in the L1 sample. There were only 4 L1 children who dropped out from the testing at Time 3, the same number as ESL children who failed to continue in the study at that point of time. The performance of the children who dropped out on various measures at Time 1 and Time 2 was not significantly different from the rest of samples of L1 and ESL children. One more reason that might cause the drop at Time 3 was the long summer holiday. The Chinese children might continue to be academically engaged over the summer, whereas L1 children might have "enjoyed" their holidays.

Table 11.

Means (and SDs) of Phonological Tasks at 4 Times by L1 and Chinese ESL Children

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>ESL</td>
<td>L1</td>
<td>ESL</td>
</tr>
<tr>
<td>Auditory</td>
<td>76.9</td>
<td>68.75</td>
<td>82.54</td>
<td>76.47</td>
</tr>
<tr>
<td></td>
<td>(21.95)</td>
<td>(17.27)</td>
<td>(13.42)</td>
<td>(13.54)</td>
</tr>
<tr>
<td>Rhyme selection %</td>
<td>47.69</td>
<td>49.49</td>
<td>57.87</td>
<td>57.84</td>
</tr>
<tr>
<td></td>
<td>(15.96)</td>
<td>(16.80)</td>
<td>(17.93)</td>
<td>(15.96)</td>
</tr>
<tr>
<td>Oddity %</td>
<td>56.79</td>
<td>58.68</td>
<td>63.02</td>
<td>67.65</td>
</tr>
<tr>
<td>Phoneme deletion %</td>
<td>39.86</td>
<td>44.26</td>
<td>52.22</td>
<td>45.29</td>
</tr>
<tr>
<td></td>
<td>(18.84)</td>
<td>(17.72)</td>
<td>(17.26)</td>
<td>(20.71)</td>
</tr>
<tr>
<td>Phono. WM %</td>
<td>62.17</td>
<td>73.65</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>(12.81)</td>
<td>(12.34)</td>
<td>(12.05)</td>
<td>(14.21)</td>
</tr>
</tbody>
</table>
These results are interesting in that the ESL children are initially at a disadvantage in the area of speech perception. Yet on other levels of phonological processing they are not at a disadvantage. Indeed they perform at a similar level or better than the L1 counterparts. Previous literature in L1 reading argues that deficits in speech perception may well be causally related to later phonological processing deficits, and that speech perception is a prerequisite for the skills involved in phonological processing tasks (see McBride-Chang, 1995, for a review). However, the results in the present study on young L2 normally achieving children do not corroborate this theory. Although Chinese ESL children performed more poorly than L1 children on the speech perception task, they did not differ from L1 children on the phonological processing tasks. These results challenge the previous research findings of poor general phonemic awareness in Chinese ESL adult and young readers (e.g., Read, et al., 1986; Huang & Hanley, 1994; Holm & Dodd, 1996). It seems that the deficits on phonemic awareness of Chinese ESL children might be only limited to the level of speech perception. The cause for this phenomenon remains unclear, however, and further research is needed.

The Effect of Language Group and Time on Vocabulary and Non-verbal Ability

Table 12 shows the means and standard deviations of vocabulary and non-verbal ability test by L1 and ESL children across the 4 times. Separate repeated measure ANOVA were conducted on PPVT-R, a measure of vocabulary knowledge, and the Matrix Analogies Test (MAT), a non-verbal ability test.
Results showed that there was a significant language group effect, $F(1, 55) = 21.85$, $p < .001$. L1 children performed better on PPVT than Chinese ESL children. It indicates that L1 children have better vocabulary knowledge of English than ESL children. This is consistent with the findings from other ESL groups (Geva & Petrulis-Wright, in press). The effect of time was significant as well, $F(3, 53) = 95.50$, $p < .001$. That is, children improved their vocabulary across the 4 times. The interaction between time and language group was significant as well, $F(3, 53) = 5.72$, $p < .01$, suggesting that even though children in both groups improved their performance over time, the improvement was more pronounced in the Chinese ESL group.

Table 12.

**Means (and SDs) of Vocabulary and Matrix Analogies Test**

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>ESL</td>
<td>L1</td>
<td>ESL</td>
</tr>
<tr>
<td>PPVT %</td>
<td>40.14</td>
<td>30.12</td>
<td>44.98</td>
<td>32.55</td>
</tr>
<tr>
<td></td>
<td>(8.19)</td>
<td>(10.61)</td>
<td>(6.82)</td>
<td>(9.71)</td>
</tr>
<tr>
<td>MAT%</td>
<td>NA</td>
<td>NA</td>
<td>20.98</td>
<td>39.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(15.02)</td>
<td>(14.98)</td>
</tr>
</tbody>
</table>

*Note.* The number of items in PPVT is 175; MAT is 64.

ANOVA on MAT, on the other hand, showed a different picture. Chinese ESL children performed significantly better than L1 children, $F(1, 55) = 15.89$, $p < .001$. It seems a common finding in the literature that the average Chinese scores on
a related non-verbal test (e.g., Raven's Matrices test) are higher than those found for L1 subjects, for all ages investigated (Chan & Vernon, 1988; Court, 1991; Huang & Hanley, 1994). Better performance on the MAT indicates better visual-spatial processing skill in these ESL children. This skill may be related to the results pertaining to the visual-orthographic skills captured in the confrontational spelling. Recall that Chinese ESL children outperformed L1 children in the visual mode context, but were inferior in the audio mode context.

**Correlations among Spelling, Reading and Phonological Processing Skills**

The simple correlations between the spelling, reading, phonological processing skills as well as with vocabulary and non-verbal ability are summarized in Table 13*. Several general observations can be drawn from the inspection of this table. First, one notes that the correlations between the spelling measure and vocabulary test were consistently low and non-significant for L1 children across the 4 times, all $r_s < .15$, whereas for ESL children they remained significantly high from Time 1 to Time 4, all $r_s > .43$. This result suggests that vocabulary knowledge plays an important role in ESL children's spelling performance, be it real words or pseudowords, but not in L1 children. As Chall (1996) points out, the beginning and normally achieving L1 reader possesses the necessary oral language tools

* Please note that the correlations listed in this table were among the real word spelling, reading and phonological measures. Those among pseudoword spelling, confrontational spelling, reading and phonological measures at Time 3 were attached in the Appendix I.
involving vocabulary and syntax to approach the beginning reading materials, whereas beginning ESL readers are still in the processes of developing their vocabulary (Geva & Petrulis-Wright, in press) and their grammatical knowledge (Johnson & Newport, 1989). In the present study ESL children performed poorer in PPVT than L1 children across the time, and individual differences in their vocabulary knowledge correlates with their spelling, whereas L1 children had a broader vocabulary and individual differences had no impact on their spelling performance at the beginning 2 years of reading instruction.

The second observation concerns the relation between non-verbal ability and spelling performance. The results showed that the correlation between the spelling task and MAT was significant for ESL children, but not for L1 children at Time 2 (\( r = .481 \), and \( r = .190 \), respectively*). Huang and Hanley (1994) found that performance on a test of visual skills was closely related to reading Chinese in Chinese children (from Hong Kong and Taiwan), whereas it was less strongly related to learning to read English by the English children. Our study replicated their results; there was a weak relation in the English-as-L1 children between MAT and spelling performance. However, it is interesting and noteworthy that in our study the strong relation between visual skills and reading extends to reading English by our Chinese ESL children. It appears that the Chinese ESL children adopt their visual (especially visual - spatial in our study) skills in learning Chinese

* Fisher's z' test (Cohen & Cohen, 1975) indicated that the two \( rs \) were not significantly different from each other, however, \( z = 1.32, p > .08. \)
into processing English words. At Time 4, however, the correlation dropped to .222 for Chinese ESL children, but increased to .395 for L1 children.

Next, it was found that the correlations between spelling measures and all three reading tasks were consistently high across the 4 times for both L1 and ESL children. This strong correlation pattern for both L1 and ESL children not only confirms previous findings reported in the literature that the emergence of decoding and spelling skills tend to be strongly interrelated, but also extends them to L2 acquisition.

Finally, the correlations between different phonological measures and spelling varied from time to time, except those between phoneme deletion and spelling measures, which were consistently high for both L1 and ESL children. This finding is consistent with findings reported in the literature that phoneme deletion is a sensitive measure for phonological processing in L1 and L2 learners as well (e.g., Geva, et al., 1993; Stanovich, et al. 1984; Yopp, 1988; Wade-Woolley & Siegel, 1997). The correlations between phonological working memory and spelling measures were not significant for L1 children but consistently high for ESL children across the 4 times. This finding adds to the growing body of L2 acquisition research where working memory was found to play an important role in L2 acquisition of

---

Again, Fisher's z' test indicated that the two rs were not significantly different from each other, \( z = .69, p > .2 \).
Table 13.

**Simple Correlations between Spelling, Reading and Phonological Processing Skills at Each Testing Time**

<table>
<thead>
<tr>
<th></th>
<th>Language groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1 (N=36)</td>
</tr>
<tr>
<td></td>
<td>ESL (N=35)</td>
</tr>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
</tr>
<tr>
<td><em>Real word spelling with:</em></td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>.054</td>
</tr>
<tr>
<td></td>
<td>.571**</td>
</tr>
<tr>
<td>Spelled word reading</td>
<td>.832**</td>
</tr>
<tr>
<td></td>
<td>.824**</td>
</tr>
<tr>
<td>WRAT reading</td>
<td>.865**</td>
</tr>
<tr>
<td></td>
<td>.839**</td>
</tr>
<tr>
<td>Word Attack</td>
<td>.797**</td>
</tr>
<tr>
<td></td>
<td>.779**</td>
</tr>
<tr>
<td>Auditory discrimination</td>
<td>.479**</td>
</tr>
<tr>
<td></td>
<td>.348</td>
</tr>
<tr>
<td>Phyme selection</td>
<td>.166</td>
</tr>
<tr>
<td></td>
<td>.436*</td>
</tr>
<tr>
<td>Oddity</td>
<td>.484**</td>
</tr>
<tr>
<td></td>
<td>.261</td>
</tr>
<tr>
<td>Phoneme deletion</td>
<td>.412*</td>
</tr>
<tr>
<td></td>
<td>.673**</td>
</tr>
<tr>
<td>Phonological working memory</td>
<td>.255</td>
</tr>
<tr>
<td></td>
<td>.413*</td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
</tr>
<tr>
<td><em>Real word spelling with:</em></td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>.109</td>
</tr>
<tr>
<td></td>
<td>.550**</td>
</tr>
<tr>
<td>MAT</td>
<td>.190</td>
</tr>
<tr>
<td></td>
<td>.481**</td>
</tr>
<tr>
<td>Spelling selection</td>
<td>.787**</td>
</tr>
<tr>
<td></td>
<td>.885**</td>
</tr>
<tr>
<td>Spelled word reading</td>
<td>.736**</td>
</tr>
<tr>
<td></td>
<td>.873**</td>
</tr>
<tr>
<td>WRAT reading</td>
<td>.774**</td>
</tr>
<tr>
<td></td>
<td>.934**</td>
</tr>
<tr>
<td>Word Attack</td>
<td>.666**</td>
</tr>
<tr>
<td></td>
<td>.888**</td>
</tr>
<tr>
<td>Auditory discrimination</td>
<td>.362*</td>
</tr>
<tr>
<td></td>
<td>.555**</td>
</tr>
<tr>
<td>Phyme selection</td>
<td>.311</td>
</tr>
<tr>
<td></td>
<td>.435*</td>
</tr>
<tr>
<td>Oddity</td>
<td>.448**</td>
</tr>
<tr>
<td></td>
<td>.435*</td>
</tr>
<tr>
<td>Phoneme deletion</td>
<td>.506**</td>
</tr>
<tr>
<td></td>
<td>.652**</td>
</tr>
</tbody>
</table>

*Correlation is significant at the .05 level (2-tailed).

**Correlation is significant at the .01 level (2-tailed).
(Cont'd)

<table>
<thead>
<tr>
<th>Language groups</th>
<th>L1</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 3</td>
<td>(N=32)</td>
<td>(N=30)</td>
</tr>
<tr>
<td>Real word spelling with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>-.118</td>
<td>.663**</td>
</tr>
<tr>
<td>WRAT reading</td>
<td>.787**</td>
<td>.894**</td>
</tr>
<tr>
<td>Word Attack</td>
<td>.751**</td>
<td>.880**</td>
</tr>
<tr>
<td>Auditory discrimination</td>
<td>.395*</td>
<td>.141</td>
</tr>
<tr>
<td>Phyme selection</td>
<td>.472**</td>
<td>.336</td>
</tr>
<tr>
<td>Oddity</td>
<td>.475**</td>
<td>.304</td>
</tr>
<tr>
<td>Phoneme deletion</td>
<td>.512**</td>
<td>.620**</td>
</tr>
<tr>
<td>Phonological working memory</td>
<td>.149</td>
<td>.609**</td>
</tr>
<tr>
<td>Time 4</td>
<td>(N=28)</td>
<td>(N=29)</td>
</tr>
<tr>
<td>Real word spelling with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>.138</td>
<td>.711**</td>
</tr>
<tr>
<td>MAT</td>
<td>.395*</td>
<td>.222</td>
</tr>
<tr>
<td>Spelling selection</td>
<td>.657**</td>
<td>.771**</td>
</tr>
<tr>
<td>Spelled word reading</td>
<td>.733**</td>
<td>.849**</td>
</tr>
<tr>
<td>WRAT reading</td>
<td>.639**</td>
<td>.832**</td>
</tr>
<tr>
<td>Word Attack</td>
<td>.695**</td>
<td>.883**</td>
</tr>
<tr>
<td>Auditory discrimination</td>
<td>.445*</td>
<td>.089</td>
</tr>
<tr>
<td>Phyme selection</td>
<td>.522**</td>
<td>.353</td>
</tr>
<tr>
<td>Oddity</td>
<td>.411*</td>
<td>.371*</td>
</tr>
<tr>
<td>Phoneme deletion</td>
<td>.442*</td>
<td>.664**</td>
</tr>
<tr>
<td>Phonological working memory</td>
<td>.220</td>
<td>.539**</td>
</tr>
</tbody>
</table>

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).
vocabulary knowledge (e.g., Gathercole & Adams, 1993, 1994; Gathercole, et al., 1997; Geva & Ryan, 1993; Schuster & Geva, 1999). Geva and Ryan (1993) found that working memory plays even a more important role in L2 reading of elementary school children than in L1 reading. The reason might be, according to these researchers, due to the heavier demands posed on working memory by the lack of automaticity in executing component processes underlying the word reading in L2 relative to L1 reading. Correlations between spelling and other phonological measures such as rhyme selection and oddity test as well as auditory discrimination task were not consistent across the time and language group.

After discussing the above correlations between spelling and various measures, we were curious about the close relationship between vocabulary measured by PPVT and ESL children's spelling performance. As it was found that phonological memory also correlated highly with spelling in ESL children across the time, and from the literature we know that there is ample evidence supporting the important role of working memory in L2 vocabulary growth, we were interested to see whether the high correlations between vocabulary and spelling in ESL children could be understood in terms of the contribution of phonological working memory. Partial correlations between PPVT and real word spelling after controlling for phonological working memory are listed in Table 14.

---

11 The partial correlations between PPVT and pseudoword spelling, PPVT and confrontational spelling after controlling for phonological working memory are attached in the Appendix J.
It appears that there was only a slight drop in the correlations for ESL children between PPVT and real word spelling at 3 times after controlling for phonological working memory. Those correlations were still significant at .01 level. This suggests that vocabulary seems to correlate with real word spelling independent of phonological working memory. One reason might be due to the fact that all the items in real word spelling are highly frequent words.

Table 14.

Partial Correlations between Vocabulary and Spelling after Controlling for Phonological Working Memory across Time

<table>
<thead>
<tr>
<th>Controlling for</th>
<th>T1 L1</th>
<th>T1 ESL</th>
<th>T3 L1</th>
<th>T3 ESL</th>
<th>T4 L1</th>
<th>T4 ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPVT with</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real Word Spell</td>
<td>-019</td>
<td>0.530**</td>
<td>-139</td>
<td>0.591**</td>
<td>0.102</td>
<td>0.577**</td>
</tr>
<tr>
<td></td>
<td>(0.054)</td>
<td>(0.571**)</td>
<td>(-118)</td>
<td>(0.663**)</td>
<td>(0.138)</td>
<td>(0.711**)</td>
</tr>
</tbody>
</table>

Note. For the purpose of comparison, the correlations before partialling out phonological working memory are listed in the parentheses.
* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).

Contributions of Underlying Cognitive Factors to Spelling

The above correlational data showed that all 3 reading measures were highly correlated with the spelling task. The 3 reading tasks were combined by computing factorial scores after factor analyses. The same procedure was applied to the phonological measures. That is, the 3 reading measures were combined to form a single reading factor, and the 5 phonological tasks were combined to form a single phonological factor. Vocabulary, MAT, reading score, and phonological
score were entered into a multiple regression as predictor variables of spelling performance. In order to examine the contribution of reading and phonological processing to spelling after partialling out the variance accounted for by vocabulary and non-verbal ability, the entry order of the predictors was always vocabulary/MAT first, followed by reading/phonological scores. The entry order between vocabulary and MAT, between reading and phonological factor scores was reversed in the second section of each analysis. The results of a fixed-order regression analyses are presented in Table 15.

These data indicate that for both L1 and ESL children alike, after controlling for PPVT (at Time 1, 2, 3 and 4) and MAT (at Time 2 and 4), reading tasks accounted for significant amount of variance in predicting real word spelling – spelling generation (e.g., at Time 1, $R^2 = 76\%$, $p < .001$ for L1; and $35\%$, $p < .001$, for ESL children, respectively) and spelling selection – spelling recognition (e.g., at Time 2, $R^2 = 56\%$, $p < .001$ for L1; and $45\%$, $p < .001$ for ESL children). This was true even when the phonological factor preceded the reading factor.

The phonological processing factor did not account for significant amount of variance in predicting real word and spelling selection when entered into the regression equation after the reading factor, but they did when entered before the reading factor for both L1 and ESL at Time 1, 2, 3. For instance, at Time 1, for L1 children the phonological factor accounted for only .3% variance when entered

---

*We listed the real word spelling and spelling selection as the separate dependent variables in this table. The results based on pseudoword spelling and confrontational spelling as the dependent variables are attached in the Appendix K.*
after the reading factor, whereas it accounted for 31% if entered before the reading factor. This is still the case for L1 children at Time 4, whereas for ESL children the phonological factor no longer explain the significant variance even when entered before the reading factor.

In general these results indicate that phonological processing skills overlap with reading skills when predicting spelling performance for both L1 and ESL children. This is no surprise, given the findings in the literature of high correlations between reading and phonological processing, and phonological processing predicting reading in both L1 and L2 learners.

Another interesting finding is that for ESL children, in addition to what the decoding factor and the phonological factor contribute to spelling performance, vocabulary knowledge and non-verbal ability make significant contributions to spelling. This was not the case for L1 children, however. It seems that various types of knowledge contribute concurrently to the spelling development in ESL children. The next Chapter will provide detailed discussion on this topic.
### Table 15.

**Summary of Fix-order Multiple Regression Analyses for Predicting Children's Spelling Performance**

**Time 1 & 2:**

<table>
<thead>
<tr>
<th>Step</th>
<th>Variables</th>
<th>L1</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Multiple R</td>
<td>β</td>
</tr>
<tr>
<td>Predict real word spell. at T1:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PPVT</td>
<td>.070</td>
<td>.003</td>
</tr>
<tr>
<td>2</td>
<td>reading factor</td>
<td>.872</td>
<td>.923</td>
</tr>
<tr>
<td>3</td>
<td>phonological factor</td>
<td>.873</td>
<td>-.075</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>phonological factor</td>
<td>.563</td>
<td>-.075</td>
</tr>
<tr>
<td>3</td>
<td>reading factor</td>
<td>.873</td>
<td>.923</td>
</tr>
</tbody>
</table>

Predict real word spell. at T2:

<table>
<thead>
<tr>
<th>Step</th>
<th>Variables</th>
<th>L1</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>-.105</td>
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<td>MAT</td>
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<td>.081</td>
</tr>
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<td>.797</td>
<td>.796</td>
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<td>4</td>
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<td>.797</td>
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<td>Or</td>
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</tr>
<tr>
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<td>MAT</td>
<td>.190</td>
<td>.081</td>
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<td>PPVT</td>
<td>.198</td>
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<td>3</td>
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<td>.545</td>
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<td>.796</td>
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Predict spelling selection at T2:

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<td></td>
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<td>β</td>
</tr>
<tr>
<td>1</td>
<td>PPVT</td>
<td>.096</td>
<td>-.059</td>
</tr>
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<td>2</td>
<td>MAT</td>
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</tr>
<tr>
<td>3</td>
<td>reading factor</td>
<td>.755</td>
<td>.805</td>
</tr>
<tr>
<td>4</td>
<td>phonological factor</td>
<td>.756</td>
<td>-.047</td>
</tr>
<tr>
<td>Or</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>1</td>
<td>MAT</td>
<td>.022</td>
<td>-.082</td>
</tr>
<tr>
<td>2</td>
<td>PPVT</td>
<td>.097</td>
<td>-.059</td>
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<td>.474</td>
<td>-.047</td>
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<tr>
<td>4</td>
<td>reading factor</td>
<td>.756</td>
<td>.805</td>
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* p <.05, ** p <.01, *** p <.001
(Cont'd)

### Time 3 & 4:

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<td>2</td>
<td>reading factor</td>
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<td>.707</td>
</tr>
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<td>3</td>
<td>phonological factor</td>
<td>.803</td>
<td>.110</td>
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<tr>
<td>Or</td>
<td>phonological factor</td>
<td>.673</td>
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</tr>
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Predict real word spell. at T3:

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<td>3</td>
<td>reading factor</td>
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<td>.711</td>
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<td>4</td>
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<td>.717</td>
<td>.129</td>
</tr>
<tr>
<td>Or</td>
<td>phonological factor</td>
<td>.342</td>
<td>-.120</td>
</tr>
<tr>
<td>3</td>
<td>reading factor</td>
<td>.342</td>
<td>-.094</td>
</tr>
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<td>4</td>
<td>phonological factor</td>
<td>.520</td>
<td>.129</td>
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<td>Or</td>
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<td>.711</td>
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</table>

Predict spelling selection at T4:

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<th>EFL</th>
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<td>2</td>
<td>MAT</td>
<td>.448</td>
<td>.113</td>
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<tr>
<td>3</td>
<td>reading factor</td>
<td>.610</td>
<td>.373</td>
</tr>
<tr>
<td>4</td>
<td>phonological factor</td>
<td>.641</td>
<td>.279</td>
</tr>
<tr>
<td>Or</td>
<td>phonological factor</td>
<td>.448</td>
<td>.113</td>
</tr>
<tr>
<td>2</td>
<td>PPVT</td>
<td>.448</td>
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</tr>
<tr>
<td>3</td>
<td>phonological factor</td>
<td>.586</td>
<td>.279</td>
</tr>
<tr>
<td>4</td>
<td>reading factor</td>
<td>.641</td>
<td>.373</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01, *** p < .001
The Effect of Language Group and Time on Phonological Processing "sh" and "th"

Means and standard deviations of the performance on "sh" and "th" in auditory discrimination, rhyme, and oddity tasks within the 2 language groups across the 4 times are listed in Table 16. Several repeated measures ANOVAs revealed that the effect of language groups on the phoneme "sh" was not significant for any of the 3 phonological tasks (all ps >.1). The effect of language group on phoneme "th" was only significant for the auditory discrimination task, $F(1, 52) = 9.17, p < .01$, but not for the other tasks (both ps > .3). As to the effect of time, for the "sh" phoneme it was significant for rhyme, $F(3, 50) = 17.72, p < .001$, and marginally significant for oddity (i.e., onset detection), $F(3, 48) = 4.10, p = .011$, but not significant for auditory discrimination, $F(3, 50) = 2.17, p > .1$. For the "th" phoneme, the effect of time was significant for all the 3 measures, all ps < .01. With regard to interactions, it was only significant between the performance of "th" in auditory discrimination and the time, $F(3, 50) = 4.54, p < .01$, all the rest were not significant, all ps > .05. The significant interaction for "th" in auditory discrimination with time was due to the significant increase in the performance of ESL children by Time 3.

This result indicates that ESL children did not appear to differ from L1 children when processing "sh" and "th" phonemes on the 3 phonological measures, except for "th" in the auditory discrimination task early on. Consistent with the results in the performance on total scores of the 4 phonological tasks, Chinese ESL children were also as accurate as L1 children in processing those items.
containing the elements which impose difficulty in the spelling task (i.e., “th” in “teeth”, “sh” in “ship”).

Table 16.

Means (and SDs) of Items Containing Specific Phonemes in 3 Phonological Tasks at 4 Times by L1 and Chinese ESL Children

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>ESL</td>
<td>L1</td>
<td>ESL</td>
</tr>
<tr>
<td>Auditory</td>
<td>88.89</td>
<td>83.13</td>
<td>90.86</td>
<td>89.41</td>
</tr>
<tr>
<td>descrim</td>
<td>(16.87)</td>
<td>(15.33)</td>
<td>(16.34)</td>
<td>(18.58)</td>
</tr>
<tr>
<td></td>
<td>65.74</td>
<td>53.65</td>
<td>63.33</td>
<td>54.90</td>
</tr>
<tr>
<td>Rhyme</td>
<td>53.92</td>
<td>56.06</td>
<td>72.22</td>
<td>73.53</td>
</tr>
<tr>
<td>selection</td>
<td>(25.97)</td>
<td>(29.11)</td>
<td>(27.02)</td>
<td>(25.66)</td>
</tr>
<tr>
<td></td>
<td>36.36</td>
<td>34.85</td>
<td>41.43</td>
<td>43.14</td>
</tr>
<tr>
<td></td>
<td>(16.38)</td>
<td>(22.19)</td>
<td>(22.64)</td>
<td>(23.25)</td>
</tr>
<tr>
<td>Oddity</td>
<td>61.43</td>
<td>62.50</td>
<td>67.14</td>
<td>63.73</td>
</tr>
<tr>
<td></td>
<td>48.61</td>
<td>51.04</td>
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<tr>
<td></td>
<td>(22.67)</td>
<td>(23.16)</td>
<td>(23.53)</td>
<td>(18.32)</td>
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</tbody>
</table>

Note: The number of items with phoneme “sh” in: Auditory Discrimination Task = 5; Rhyme Selection Task = 6; Oddity Task = 6.

Summary

In this chapter L1 and Chinese ESL children's performance on various reading and phonological processing tasks, as well as their vocabulary and non-verbal ability were examined across time. Consistent with the findings on spelling tasks, the time effect was generally significant in both language groups across task
varying in task demands. Overall, there is no significant difference between the 2 language groups on basic reading skills and in fact, ESL outperformed L1 children in WRAT reading.

The comparison between the spelling and reading accuracy on the 3 words (SHIP, TEETH, THICK) indicates that there seems to be some inconsistency between reading and spelling for ESL children, but not for L1 children. In particular, ESL children were able to read these words more accurately than they were able to spell them. Chinese ESL children were poorer in auditory discrimination involving novel phonemes than L1 children, but not in other levels of phonological processing, such as onset and rhyme detection, phoneme deletion, and phonological working memory. As might be expected, L1 children had better vocabulary knowledge than ESL children. At the same time, ESL children had better non-verbal reasoning skills than the L1 children.

Correlational analyses showed that both L1 and ESL children's spelling performance correlated significantly with reading measures at each testing period. Phoneme deletion was found to correlate significantly with the spelling task for the 2 groups at each testing period. Phonological working memory correlates significantly with spelling in the ESL children but not in the L1 group. Interestingly, the correlation between spelling and vocabulary was highly significant for ESL children but not for L1 children. As well, the non-verbal ability tested by MAT was correlated with spelling for ESL children at Time 2, but not for L1 children, however, by Time 4, the direction reversed.
Regression analyses revealed that after controlling for vocabulary and non-verbal ability reading factor accounted for significant amount of variance in predicting performance on the spelling measures (real word and spelling selection) for both L1 and ESL children. The phonological factor accounted for a significant amount of variance in predicting the spelling performance for both L1 and ESL when entered before the reading factor across the time, but became non-significant when entered after the reading factor.

Moreover, the ESL children did not differ from L1 children in processing the “sh” phoneme in 3 phonological tasks. They did not differ from each other in processing “th” in the onset and rhyme detection, either, but they did differ in discriminating “th” in the auditory discrimination task.
CHAPTER 6: GENERAL DISCUSSION

In this thesis we examined the spelling development of English-as-L1 and Chinese ESL children, and looked at how one’s L1 affects spelling development in L2. We also investigated the relationship between spelling, reading, phonological processing in the two language groups. The general discussion of the results will be organized around a few main issues raised in this thesis. Limitations and future research will be discussed at the end.

The Effect of L1 Transfer and the Contribution of the Present Study

The present study contributes to the existing literature on spelling development in ESL children. It provides evidence for both positive and negative transfer in spelling development from logographic script (i.e., Chinese) as L1 to alphabetic script (i.e., English) as L2, and this transfer effect is evident even with young ESL children with limited L1 literacy exposure.

The effect of L1 negative transfer is evident in our various spelling tasks. In the real word spelling task, Chinese ESL beginning readers had difficulty in spelling words with “th” and “sh”. Error analyses indicate that Chinese ESL children had imprecise phonological representations of these phonemes which affected their spelling of certain digraphs. To review, one dominant error in spelling is to use “s” for “sh”, and “s” or “z” for “th”. The negative transfer effect manifests in that Chinese ESL children seem to borrow the closest phoneme from L1 to map the phoneme. In the case of “f” for “sh” or “th”, it could be that because
there is no easy mapping for the phoneme, some phonemes from the L1 might intrude. The pattern of spelling errors of these phonemes in ESL children reflects the difficulty in forming new phonological representations. This observation supports Fowler’s (1991) argument on the importance of early phonological representations changes in L1 children. According to Fowler (1991) and others whose research was in line with and extended Fowler’s argument (e.g., Elbro, 1996; Elbro, Borstrom, & Peterson, 1998; Hulme & Snowling, 1992; Metsala, 1997; Swan & Goswami, 1997), the accuracy of the underlying phonological representations of the words is critical to success on reading and writing. When learning to read and write a L2, children have to undergo fundamental phonological representational changes in the direction of L1. At the same time, they also have to combat the phonological transfer problem from their L1, for example, to form certain new phonological representations which are absent in their L1. The imprecise phonological representations of certain phonemes in Chinese ESL children evident in the present study exemplifies the specific challenge caused by their L2 status. The current results also demonstrate how gradually these phoneme-specific difficulties disappear as children’s English language skills improve.

In another analysis which focused on a comparison of spelling performance on the two digraphs “th” and “ck” in word “thick”, L1 children experienced more difficulty in spelling the digraph “ck” than “th”. Chinese ESL children, on the other hand, experienced similar difficulty in spelling both elements. We would argue that ESL children have primarily a phonological transfer problem with
regard to “th” and orthographic problem primarily with “ck”. L1 children do not have to overcome a phonological transfer problem, though they have to acquire the rules involving the phoneme /k/ at the end of words, just the way ESL children do.

The difficulty of Chinese ESL children on spelling “th” is reflected also in the specific difficulty in auditory discrimination task, where they were required to detect the differences in the pairs of pseudowords containing “th” units in speech. This finding is consistent with the consensus on the relation between speech and writing in L1 literature. According to Olson (1994), in learning to write, children must work out the relations between the letters they recognize and the phonemes they can recognize, categorize or differentiate in their own oral speech. In other words, if L2 children fail to perceive and recognize some of the phonemes of L2, they will experience difficulty in representing these phonemes in spelling. Consequently they will spell it with an approximation to the phonemes (Olson, 1999, personal communication).

The negative transfer effect in Chinese ESL children is also evident in their spelling pseudowords without lexical access. In the pseudoword spelling task, the effect of lexicality was strong in that Chinese ESL children spelled real words significantly more accurately than pseudowords. The difficulty in spelling pseudowords may result from the fact that in reading and spelling these ESL children are more likely to benefit from a whole-word, visual strategy but also more challenged on tasks aimed at the assembled phonology.
The present study demonstrates the prominent negative transfer effect in learning to spell from a non-alphabetic L1 to an alphabetic L2. There also exits an interesting and exciting positive transfer effect for these young Chinese ESL children. The strong evidence of positive transfer comes from the results in the confrontation pseudoword spelling task. Chinese ESL children outperformed L1 children in spelling orthographically illegitimate (unpronounceable) letter strings. Moreover, they were more accurate in spelling the same pseudowords when they were presented visually than when they were presented orally. These results indicate that they have more difficulty in phonologically recoding words, yet this did not affect the English word spelling in Chinese ESL children as much as it did L1 children. They can compensate for this by relying on visual-orthographic processing skills when phonological information is not easily accessible. This suggestion might find support from the results involving the MAT. Recall that Chinese ESL children outperformed the L1 children on this task which draws heavily on visual skills. More evidence of positive transfer comes from Chinese ESL children’s superior performance on a spelling selection task, which reflects their strong orthographic processing or visual representation skills. Together with Koda’s findings on Japanese adult readers (Koda, 1987; 1989) it seems that not only adult but also young logographic readers transfer their orthographic processing skills in L1 to L2 reading and spelling even when they are not completely fluent in writing Chinese.
It is worth noting, however, that the present study not only contributes to the existing body of literature on language transfer effects from L1 to L2, but it makes its contribution in a unique and important way. Previous research has addressed the language transfer issue in L2 learning mainly from the perspective of adult learners. Very few studies examined this transfer effect in L2 children. The transfer model described in the literature is somewhat static (Geva, 1999, personal communication). The data published were mostly anecdotal and based on case studies of L2 learners at a single age group of adults (e.g., Ioup & Weiberger, 1987; James & Leather, 1987). The present study tests this model within a developmental framework. The results from the present study make an important contribution to the existing theoretical frameworks on language transfer. It was found that both L1 and L2 young readers improved their performance on reading and spelling over time, and that in these normally achieving children the negative transfer effect only exists at the initial stages of L2 learning and that we have provided evidence that it gradually diminishes. As children’s proficiency in L2 increases they show similar developmental trajectories to those noted in L1 children. This type of evidence can be shown only within a longitudinal framework. The different role of language transfer in different stages of L2 acquisition relates to a theoretical discussion of issues concerning universal and language-specific processes in L1 and L2 literacy acquisition and the role of oral language in L2 literacy acquisition.
Universal or Language-Specific Learning Processes of L2?

The second language learning literature is dominated by two major models, one based on the assumption that acquisition procedures are universal across languages (e.g., Eckman, 1981; Jakobson, 1941; Rutherford, 1982), and the other, on the conviction that acquisition involves language-specific processes (e.g., Akamatsu, 1999; Koda, 1994, Wode-Woolley, 1996; Verhoeven, 1990). The universal position holds that acquisition of a given language by L2 learners parallels closely its acquisition by L1 learners which reflects common underlying cognitive processes. The language-specific view posits that L1 linguistic processes affect the acquisition of a new linguistic system, and many of the difficulties faced and solutions attempted during L2 development can be predicted by a contrastive analyses of the two systems. How do the results of the research reported here inform these seemingly contradicted models?

The English word spelling data show that for L1 and ESL children there exists a similar developmental trajectory. On the surface these results support the universal model. However, by employing qualitative error analyses it was possible to show that the spelling of certain words was more difficult for Chinese children and this difficulty stemmed from difficulty with spelling certain phonemes that are absent in the L1 phonology. Moreover, we showed that these Chinese children had difficulty also in performing an auditory discrimination task involving these phonemes. It seems that neither the universality nor the language transfer model alone can provide an adequate explanation of L2 spelling development. Instead,
this development can be best accounted for by an interaction between the general development of grapheme-phoneme correspondence knowledge and transfer from L1. The language-specific model best predicts the exceptionally low spelling levels for words with certain L1-specific phonological or orthographic features, while the universal model best predicts the general order of difficulty in spelling development of English words.

The interaction between universality and the language-specific model also applies to the results pertaining to the role of individual differences on the relationship between spelling, reading, and phonological processing. High correlations were found between reading and spelling for both ESL children and L1 children. After controlling for vocabulary (i.e., language proficiency) and non-verbal ability, reading measures accounted for significant amount of variance in predicting performance in both spelling generation (i.e., the real word spelling) and spelling recognition (i.e., the spelling selection). This result reveals the common underlying processing component (i.e., decoding skills) in predicting spelling performance in L1 and L2. However, L1-specific processing also has a role in explaining the individual differences. For example, when predicting confrontational spelling, the reading score was still a significant predictor for L1 children but not for ESL (see Appendix K). It might be due to the fact that when spelling orthographically illegitimate (phonetically unpronounceable) letter strings L1 children tend to rely on an assembled phonology applied to the orthographically legitimate (phonetically pronounceable) words. Chinese ESL
children, on the other side, relied on visual processing skills instead of decoding skills.

Therefore, we suggest that the universal and language-specific models are not mutually exclusive, but rather they work together in a complementary fashion. As was shown in a couple of recent studies on concurrent development of basic reading skills in L1 and L2 (e.g., Geva & Siegel, 2000; Gholamain & Geva, 1999), both models were supported by the research evidence. In these studies, the universal hypothesis was supported by the common underlying cognitive processes for L1 and L2 acquisition, such as verbal working memory and rapid automatized naming. On the other side, the orthographic-specific hypothesis was supported by the evidence of the ease with which children develop their reading skills in a less complex script or “shallow” orthography, for example, Hebrew or Persian.

It is worth pointing out that one additional contribution the present study made in explaining the interaction between universal and language-specific processes is to highlight the importance of the stage of L2 learning. Results suggest that the language-specific model better applies to early stages of L2 acquisition, and better predicts L2 children's acquisition of L1-specific structures of L2. During the course of L2 development, the language transfer effect gradually decreases, while universal development processes increase\(^3\). This interrelationship between

\(^3\) Please note that the results from this thesis are suggestive of some general trends, further research is needed before any conclusive statements can be offered.
developmental and interlingual processes was also mentioned in a few studies focusing on L2 adult readers (Major, 1987, 1994; Ross, 1994). These researchers showed evidence of how their subjects' errors in production of grammatical structures or syllable structures shift from L1-related to ones appropriate to L2.

**The Role of Visual Processing in Chinese ESL Children's Reading and Spelling**

There is ample evidence in the literature suggesting that visual skills, and visual-reasoning in particular may play an important role in learning to read Chinese (Ho & Bryant, 1997; Hoosain, 1991; Huang & Hanley, 1994). To review, Huang and Hanley (1994) observed that visual skills were significantly correlated with reading abilities in eight-year-old children from Taiwan and Hong Kong, but not in children from Britain. Similarly, Ho and Bryant (1997a) found that differences in visuo-perceptual skills in preschool children from Hong Kong were a significant predictor of reading ability a year later. It is of no surprise why visual skills are important in learning to read Chinese; the written characters in Chinese are more visually distinct than words written in an alphabetic script. A child must learn to distinguish thousands of different visual symbols if he or she is to become proficient in reading Chinese.

Interestingly, in the present study, we found evidence for the role of visual processing in young Chinese children learning to read and spell in a second language. Support for this conjecture comes from the significant correlations between the MAT and spelling performance. MAT contains a visual skills
component. The significant correlation between the spelling task and MAT for Chinese ESL children but not for L1 children at Time 2 indicates that visual processing is closely related to Chinese ESL children’s spelling performance in English, but not to L1 children’s spelling performance.

Another piece of evidence concerning the effect of visual processing skills on spelling came from the comparison of spelling performance of pseudowords common to audio presentation and visual presentation. It was found that the difference between correct spellings via the two presentation modes was significantly larger for Chinese ESL children than for L1 children. Chinese ESL children performed much better in visual presentation than audio presentation. This result suggests that Chinese ESL children may rely more on visual information, and visual memory skills in spelling, rather than utilizing a phonological strategy, a route which may be at advantage by the L1 children. The advantage that Chinese children have when orthographic patterns were presented visually was also reflected in the confrontational spelling task where Chinese children outperformed L1 children in spelling both pronounceable and unpronounceable pseudowords.

On the whole, these results clearly suggest that visual processing skill is not only important in learning to read and write in Chinese, it is also applied when young ESL children are learning to read and write in an alphabetic language such as English. This finding could be considered as a consequence of positive transfer from L1 to L2. It could also be interpreted as a possible compensatory strategy
employed by these ESL children, given that their lack of ESL proficiency can be located at various linguistic levels including their knowledge of vocabulary and their ability to perceive new phonemic elements.

Concurrent Development in a Number of Domains in ESL Children

The present study reveals that ESL beginning readers' vocabulary knowledge was very low compared to L1 children. The correlation between spelling measures and vocabulary remained significantly high for ESL children across the time, but was consistently low and non-significant for L1 children. A similar pattern was also noted for the correlations between word reading measures and vocabulary. This different relationship between vocabulary and reading and spelling in L1 and ESL children can be explained by Chall's (1996) model. She pointed out that the beginning and normally achieving L1 reader has the necessary oral language tools involving vocabulary and syntax to approach the beginning reading task. The child’s oral vocabulary may in fact exceed the vocabulary found in beginning texts. With continuing development, the language and content of the reading materials begin to parallel and surpass the child’s language development thus contributing further to language development. L2 beginning readers in grade 1, however, do not have the necessary resources such as sufficient vocabulary (also see Geva & Petrulis-Wright, in press) and syntactic knowledge (Johnson & Newport, 1989) to approach the beginning reading task as would the average L1. It suggests that ESL children’s development in oral language proficiency, reading
and spelling occurs concurrently whereas L1 children’s oral language skills precede reading and writing. It is also worth noting that there was only a slight drop in the correlations between the spelling and vocabulary for ESL children after controlling for phonological working memory. It seems that vocabulary correlates with spelling independent of phonological working memory for ESL children.

One may argue that the low correlation between vocabulary and spelling, vocabulary and reading for L1 children may be due to the fact that all words used in the real word spelling task were highly frequent and therefore, the effect of vocabulary on the spelling task was negligible. However, the results on the effect of lexicality on the spelling performance showed that the high frequency of the spelling words also had an effect on ESL children’s performance. So if it is the high frequency of the spelling items that causes the low correlation between vocabulary and spelling in L1, then the same pattern should be observed on ESL children as well, that is, the correlation between the vocabulary and spelling would be low for ESL children as well. Our results did not support this speculation. In other words, the high frequency words were also familiar to the ESL children both in terms of their meaning and their written form.

**Educational Implications**

Aside from the above theoretical contributions, the present study also has implications for assessment and instruction of ESL at-risk children. As L2 learning has its universal and L1-L2 specific aspects which work together in a
complementary fashion, teachers should understand what aspects of L2 acquisition are universal and what aspects are language-specific. The findings from the present study provide information about specific linguistic units which would be more challenging to children with given L1 backgrounds and the rate at which these units are mastered by normally achieving ESL children who receive instruction in English. Classroom teachers should be aware of this negative language transfer effect in ESL children. Rather than simply marking L1-specific errors as incorrect, the teachers could perhaps explicitly point out that these phonological and orthographic units in English are unique or different from the ones in L1. Consequently, instructional materials should be adjusted toward the needs of these children. This recommendation is noted in Snow, Burns, and Griffin (1998)'s national reading panel report as well. ESL-sensitive assessment should be developed to enable teasing apart difficulties associated with normal L2 reading acquisition from general warning signs of reading failure among ESL-at risk children (Geva, 2000, in press).

Moreover, the present study helps gain a better understanding of the development and relevance of prerequisite skills in ESL young readers. For instance, the results indicate that lack of ESL proficiency does not prevent them from learning to read and spell, though better proficiency is related to relatively better reading and spelling. Good L2 vocabulary instruction is crucial in developing ESL literacy skills. For instance, certain methods such as oral story reading could be used to foster ESL children's vocabulary knowledge.
Limitations and Future Research

As with any study, the present study has some limitations that can provide directions for future research. First, due to the fact that this study is part of a large scale longitudinal project investigating various areas of reading, writing and oral language development in several language groups, there was a limit on the amount of testing to which each child could be exposed. This meant that not all tasks were administered in each testing period. For instance, spelling selection was not tested at Time 1 and Time 3, and the spelled word reading data were not administered at Time 3. Thus, it was difficult to compare performance across time for all the tasks. Moreover, due to time constraints and the age of the children, certain tasks included only a limited number of items. This restricted the power of analysis and generalizability of results. For example, the real word spelling task has only one word with the phoneme “sh”, and 3 words with “th”. Nevertheless, the results of the present research suggest that it would be worthwhile to include more items with these contrastive features. It would be also important to assess the reading or pronunciation of these items in L2. Moreover, analyses of other contrastive structures such as plural form, tense form, and consonant cluster for Chinese ESL children could be conducted to examine further the contribution of universal and language specific phenomena in normally achieving and at-risk ESL learners.

The second limitation concerns the research design to test the hypothesis that the Chinese ESL children’s difficulty in spelling “sh” and “th” was due to the
absence of these phonemes in Chinese phonology. The spelling items targeted in this thesis did not allow a full and sufficient model to test the contrastive hypothesis directly. The analyses focused on between-group comparisons and not on within-language group comparisons. Another related weakness in selecting the items for the error analyses is that we did not have sufficient items to untangle the confounding of phoneme and position in the word. Treiman (1993) noted that children tend to make more spelling errors (e.g., omission) on the final position of the syllable than the initial position. An alternative design to overcome the above limitation is to compare children's spelling performance within language groups on a set of items with the phonemes that are absent in the L1 vs. another set of items with the phonemes that are available in the L1. At the mean time, the position of the phonemes should be taken into consideration in the selection of items. An example for this design is to compare the spelling performance within both L1 and L2 children on items such as “th” in “thank” vs. “ph” in “photo” (initial position of the words); “th” in “teeth” vs. “ck” in “back” (final position of the words), in which phoneme “th” is absent in Chinese phonology, whereas phonemes “ph” and “ck” are present.

The present study did not include various L1 (i.e., Chinese) reading and writing tasks equivalent to L2. A close examination of the relationships between the performance across the two languages was not feasible in the present study. In order to examine the effect of cross-language transfer, aside from L2 reading and spelling tasks, equivalent tasks in L1 such as Chinese real word and pseudoword
reading tasks, vocabulary tasks, and various phonological processing tasks should be developed and administered to establish the direct comparison of the performance in different language systems.

A fourth limitation concerns the possible difference in terms of social economic status between the 2 language groups of children. Due to demographic trends, the 2 groups of children were sampled from different school boards in different areas of Toronto. It is likely that children in the two groups come from families with different socio-economic status. Therefore, the difference in the performance on various tasks could result, to some extent, from differences in social economic status. Future research should rule out this possibility.

The present study did not examine the effect of reading level (i.e., good, average, poor readers) on both L1 and ESL group children. As the other studies (e.g., Wade-Woolley & Siegel, 1997) showed that rather than the L1 it is the reading skill that determines the reading and spelling performance, it would be interesting to explore this aspect in the future.

Finally, the small number of subjects in each language group is a cause for concern. It may limit the power of the findings and the representativeness of a larger population of Chinese ESL children. A replication of the findings with larger samples is definitely worthwhile.
REFERENCES


APPENDIX A: DEVELOPMENTAL SPELLING TASK

Instructions:
I want you to try to write some words. I will read each word to you, then use the word in a sentence. When I say the word again, you try to write it on the line (point to the lines). Some words are hard for children at your age. Just try your best.

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

Instructions:

Now we are going to meet a new friend. His name is Nupi. He is from the planet Neptune and speaks Neptunese. He wants you to try and learn some Neptunese. He is going to say some words in Neptunese and you try to write them down. Okay? Let’s try one, okay? Write PTV. Good.

1. SPIV
2. NESH
3. POTH (/th/ like in both)
4. VIST
5. THOP (/th/ like in through)
6. SHEN
7. VESP
8. STIV
9. THEG (/th/ like in through)
10. STUV
11. BESH
12. VUST
13. SHEB
14. VISP
15. SPEV
16. GETH (/th/ like in both)
APPENDIX C: CONFRONTATION PSEUDOWORD SPELLING TASK

Instructions:

Remember Nupi? He speaks Neptunese. We are going to learn a bit more Neptunese. He is going to show you some Neptunese words and you have to write them down on this piece of paper. He is going to show them to you very quickly, so pay close attention. Okay? Let's try one (show VESP). Good.

1. PCTH
2. NESH
3. POTH
4. STKV
5. VIST
6. THCP
7. SHEN
8. THOP
9. NFSH
10. STIV
11. SHFN
12. VKST
APPENDIX D: PSEUDOWORD AUDITORY DISCRIMINATION TASK

Instructions:

You will hear two words. They aren’t real words; they are just silly words we made up. After you have heard them, please tell me if they sound the same or different.

Practice items:

bun - fun
dap - dap
mide - fide

Test items:

1.* thonn - von
2.* shen - sen
3.* sen - fen
4. togg - togg
5.* tep - tet
6. nush - nush
7.* keathe - keev
8. tekk - tekk
9.* noff - noss
10. poth - poth
11.* konn - komm
12.* meathe - meez
13. monn - monn
14. boz - boz
15. joof - joof
16.* bish - biss
17. lenn - lenn
18. tonn - tonn
19.* ting - tig
20.* thop - zop
21.* mak - mag
22. jekk - jekk
23.* noz - nov
24. noove -- noove
25.* nesh - neff
26. zeem -- zeem
27.* lup - lut
28. seek -- seek
29. tas - tas
30.* foom - shoom
31. tass - tass
32.* zam - vam
33. theak -- theak
34.* nim - nin

* The items contain two different words.
APPENDIX E: RHYME SELECTION TASK

Instructions:

First you will hear one word. Then you are going to hear 3 more words. Which of the three words does the first word rhyme with?

Practice items:

<table>
<thead>
<tr>
<th>tog</th>
<th>nig</th>
<th>cog</th>
<th>foz</th>
</tr>
</thead>
<tbody>
<tr>
<td>bim</td>
<td>cam</td>
<td>lop</td>
<td>kim</td>
</tr>
</tbody>
</table>

Test items:

1. yam  | tan  | dat  | kam |
2. lin  | fim  | min  | nig |
3. pok  | yok  | mot  | nop |
4. nep  | ket  | mek  | yep |
5. yat  | nad  | tat  | kak |
6. fap  | hap  | kang | yan |
7. tesh | tes  | pef  | yesh |
        | nef  | fesh | kes |
        | sesh | mes  | nef |
        | wef  | nes  | mesh |
        | hes  | pesh | yef |
        | nesh | kes  | hef |
13. sothe | gove | boze | pothe |
          | hove | tothe | coze |
          | hothe | jove | moze |
          | poave | fove | cothe |
          | nove | dothe | yoze |
          | nothe | pove | loaz |
APPENDIX F: ODDITY TASK

Instructions:

You will hear 3 words, pick the word that doesn’t sound like the other two.

Practice items:

<table>
<thead>
<tr>
<th>bat</th>
<th>bag</th>
<th>hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>bug</td>
<td>buck</td>
<td>gus</td>
</tr>
<tr>
<td>poj</td>
<td>dop</td>
<td>dov</td>
</tr>
</tbody>
</table>

Test items:

1. pon  bok  pom
2. nes  nen  meng
3. shat  sham  san
4. sen  shep  sheng
5. tas  fad  tat
6. thofe  zoke  thone
7. thofe  thome  voze
8. zoje  thoje  thone
9. cos  hon  hod
10. shem  sep  shed
11. mak  mat  nad
12. thofe  thowg  zove
13. shuk  fup  shung
14. vole  thone  thote
15. shon  shong  fon
16. ket  fep  fed
17. fin  shing  shim
18. thome  voaze  thove
APPENDIX G: PHONEME DELETION TASK

Instructions:

Say /cowboy/, now say it again, but don’t say /boy/.

Say /barefoot/, now say it again, but don’t say /foot/.

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
<th>Correct Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>sunshine</td>
<td>sun(shine)</td>
</tr>
<tr>
<td>2.</td>
<td>baseball</td>
<td>ball(base)</td>
</tr>
<tr>
<td>3.</td>
<td>seesaw</td>
<td>saw(see)</td>
</tr>
<tr>
<td>4.</td>
<td>picnic</td>
<td>pic(nic)</td>
</tr>
<tr>
<td>5.</td>
<td>leg</td>
<td>(l)eg</td>
</tr>
<tr>
<td>6.</td>
<td>meat</td>
<td>(m)eat</td>
</tr>
<tr>
<td>7.</td>
<td>hand</td>
<td>(h)and</td>
</tr>
<tr>
<td>8.</td>
<td>pain</td>
<td>pai(n)</td>
</tr>
<tr>
<td>9.</td>
<td>keep</td>
<td>kee(p)</td>
</tr>
<tr>
<td>10.</td>
<td>like</td>
<td>li(k)e</td>
</tr>
<tr>
<td>11.</td>
<td>train</td>
<td>(t)rain</td>
</tr>
<tr>
<td>12.</td>
<td>clap</td>
<td>(c)lap</td>
</tr>
<tr>
<td>13.</td>
<td>stop</td>
<td>(s)top</td>
</tr>
<tr>
<td>14.</td>
<td>left</td>
<td>le(f)t</td>
</tr>
<tr>
<td>15.</td>
<td>west</td>
<td>we(s)t</td>
</tr>
<tr>
<td>16.</td>
<td>belt</td>
<td>be(l)t</td>
</tr>
<tr>
<td>17.</td>
<td>stand</td>
<td>s(t)and</td>
</tr>
<tr>
<td>18.</td>
<td>spit</td>
<td>s(p)it</td>
</tr>
<tr>
<td>19.</td>
<td>grow</td>
<td>g(r)ow</td>
</tr>
<tr>
<td>20.</td>
<td>tree</td>
<td>t(r)ee</td>
</tr>
</tbody>
</table>
APPENDIX H: PHONOLOGICAL WORKING MEMORY TASK

Instructions:

This puppet came from Mars. He speaks Martian. Remember that Martian words are different from English words. Now we are going to hear some Martian words on the tape. First you will hear a bell telling you to pay attention and then you will hear a Martian word. Each time you hear a Martian word, your job is to say it. Listen carefully so you can repeat all these Martian words. Ready, listen.

Practice items:
- Boxin
- puppid
- kivven

Test items:
1. Kabbit
2. megole
3. seebus
4. popkum
5. gotty
6. pennem
7. bannop
8. subid
9. dillet
10. bannow
11. doppetate
12. bannifat
13. backazon
14. commezine
15. tickeny
16. wooganamic
17. fennegiser
18. commeeccitate
19. koddenapish
20. pennedifoot
21. consamponita
22. penpisonkerous
23. bonsemtapinger
24. soppogaticine
25. epifoventy
### APPENDIX I: CORRELATIONS BETWEEN PSEUDOWORD SPELLING, CONFRONTATIONAL SPELLING AND READING AND PHONOLOGICAL SKILLS

<table>
<thead>
<tr>
<th></th>
<th>Language groups</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1 (N=32)</td>
<td>ESL (N=30)</td>
<td></td>
</tr>
<tr>
<td>Time 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Pseudoword spelling with
- PPVT: .017, .434*
- Real word spelling: .728**, .665**
- WRAT reading: .778**, .704**
- Word Attack: .790**, .692**
- Auditory discrimination: .330, .411*
- Phoneme selection: .277, .353
- Oddity: .563**, .221
- Phonological working memory: .527**, .589**

#### Confront. pseudo. spelling with
- PPVT: -.122, .676**
- Real word spelling: .449**, .515**
- Pseudoword spelling: .363*, .378*
- WRAT reading: .562**, .390*
- Word Attack: .519**, .502**
- Auditory discrimination: .178, -.018
- Phoneme selection: .286, .094
- Oddity: .480**, .097
- Phoneme deletion: .298, .224
- Phonological working memory: .123, .166

* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).
APPENDIX J: PARTIAL CORRELATIONS BETWEEN VOCABULARY AND PSEUDOWORD SPELLING, CONFRONTATIONAL SPELLING AFTER CONTROLLING FOR PHONOLOGICAL WORKING MEMORY

<table>
<thead>
<tr>
<th>Controlling for</th>
<th>PPVT with</th>
<th>T 3</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pseudo Word Spell.</td>
<td>.006</td>
<td>.332</td>
<td>(.017)</td>
</tr>
<tr>
<td></td>
<td>Confront. Spell.</td>
<td>-.139</td>
<td>.671**</td>
<td>(.122)</td>
</tr>
</tbody>
</table>

Note. For the purpose of comparison, the correlations before partialling out phonological working memory are listed in the parentheses.

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).
APPENDIX K: SUMMARY OF FIX-ORDER MULTIPLE REGRESSION ANALYSES FOR PREDICTING PSEUDOWORD SPELLING AND CONFRONTATIONAL SPELLING AT TIME 3

<table>
<thead>
<tr>
<th>Time 3:</th>
<th>Variables</th>
<th>L1</th>
<th>ESL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step</strong></td>
<td><strong>Multiple R</strong></td>
<td><strong>β</strong></td>
<td><strong>R² change</strong></td>
</tr>
<tr>
<td>Predict pseudoword spell.:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PPVT</td>
<td>.017</td>
<td>.008</td>
</tr>
<tr>
<td>2</td>
<td>reading tasks</td>
<td>.801</td>
<td>.891</td>
</tr>
<tr>
<td>3</td>
<td>phonological tasks</td>
<td>.805</td>
<td>-.116</td>
</tr>
<tr>
<td>Or</td>
<td>phonological tasks</td>
<td>.586</td>
<td>-.116</td>
</tr>
<tr>
<td>3</td>
<td>reading tasks</td>
<td>.805</td>
<td>.891</td>
</tr>
<tr>
<td>Predict conf.pseudo.spell.:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PPVT</td>
<td>.122</td>
<td>-.115</td>
</tr>
<tr>
<td>2</td>
<td>reading tasks</td>
<td>.570</td>
<td>.499</td>
</tr>
<tr>
<td>3</td>
<td>phonological tasks</td>
<td>.572</td>
<td>.076</td>
</tr>
<tr>
<td>Or</td>
<td>phonological tasks</td>
<td>.481</td>
<td>.076</td>
</tr>
<tr>
<td>3</td>
<td>reading tasks</td>
<td>.572</td>
<td>.499</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .01, *** p < .001