L1 ORTHOGRAPHY AND ESL LITERACY: A COMPARISON OF ENGLISH, PERSIAN, AND CHINESE L1 SPEAKERS

by

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Abstract

Orthographies vary in how sounds are translated to print. Alphabetic orthographies utilize grapheme-phoneme correspondences, whereas nonalphabetic orthographies do not. The present study examined whether learning to read and spell in English as a second language was influenced by the learner's first language. The participants were 122 third-grade children (mean age: 8.88 years) with contrasting linguistic backgrounds. The sample was comprised of 45 children who's native language was English (alphabetic), 32 ESL children who's native language was Persian (alphabetic) and 45 ESL children who's native language was Chinese (nonalphabetic). The performance of the three groups was comparable on measures of reading, phonological awareness, decoding, working memory and spelling. However, the Chinese speakers scored significantly lower than the alphabetic speakers on measures of syntactic awareness and pseudoword spelling. Misspelling error analyses further revealed that although the Chinese speakers were as likely as the alphabetic speakers to produce misspellings that resembled target words in visual form and individual phonemes, they were less likely to produce misspellings that can be read to sound exactly like the target words. In addition, there was evidence for the importance of phonological reading skills, working memory and syntactic awareness in establishing a common model of spelling for children from diverse linguistic backgrounds. Overall, the findings suggest that children learning to read and spell in English as a second language are not necessarily at a disadvantage even if the structure of their first language significantly differs from that of English. However, there may be qualitative differences in strategies used to spell that are attributable to differences in grapheme-phoneme mapping experience.

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Introduction

Reading and writing are two of the leading technologies for the dissimenation of knowledge in literate cultures. For English as a second language (ESL) learners, the development of literacy not only involves an understanding of alphabetic script, but also the manipulation of symbols that represent the values and beliefs of a culture for which they are still developing familiarity (Martin & Stuart-Smith, 1998). According to the most recent census, nearly one-quarter of British Columbians identified themselves as non-native English speakers. In fact, immigration alone accounted for more than three-quarters of the population increase in British Columbia from 1996 to 2001 (Statistics Canada, 2001). In turn, an increasing number of children are entering the Canadian school system with minimal formal instruction in English and are immersed into English classrooms. It is often the case that children from immigrant families speak one language at home and are instructed in a second language at school. The children, themselves, may or may not be immigrants. Alternatively, parents may select to speak their native language at home to their children, assuming that English will eventually be acquired in school.

This trend towards bi/multilingualism raises questions as to whether current educational practices are appropriate for children with diverse first language (L1) backgrounds. Although valuing the diversity in children, educators should aim at developing comprehensive instructional strategies for a wide range of learners. To achieve such a goal, an increased awareness by educators is needed about the structure of children's L1 and how this may influence their understanding of the phonological structures in English. Previous research has produced mixed results, suggesting that bilingualism can be either an impediment or a facilitator of the development of literacy skills in a second language (Jarvis, 2000). Hence, an increasing emphasis must be placed on clarifying those particular aspects inherent in the L1 which contribute to the ease with which ESL reading and spelling are acquired in young children. In response to this gap in the literature, this study is designed to examine the extent to which ESL children's reading and spelling achievement are influenced by the adherence of their L1 orthography to the alphabetic principle.

The alphabetic principle

Orthographies represent speech in different ways, often reflective of the differences in the availability of sounds in the language. As such, writing systems vary in how they translate sounds to print. Fluent reading and spelling in alphabetic languages require the mastery of two processes: a phonological process based on the awareness of sounds in spoken words, and an orthographic process based on the visual pattern of the written language (Lennox & Siegel, 1996; Vellutino, Fletcher, Snowling, & Scanlon, 2004). Orthographic knowledge, refers to an understanding of the rules of the writing system, including letter sequencing and positional cues on letter pronunciation and spelling (Cassar & Treiman, 2004). Early learners of an alphabetic orthography must also understand that letters (graphemes) represent the smallest units of language sounds (phonemes), and that there are predictable grapheme-phoneme correspondences (GPC) and phoneme-grapheme correspondences (PGC). This is called the alphabetic principle.

Alphabetic scripts, however, are not all alike. A framework for discussing differences in reading and spelling among alphabetic orthographies is the orthographic depth hypothesis. Shallow (or transparent) orthographies, such as Finnish and Italian, have more predictable grapheme-phoneme mappings. In contrast, deep (or opaque) orthographies, such as French and English, have complex grapheme-phoneme mappings. In English, for instance, a single grapheme may represent several phonemes (e.g., CH as in [k] for <u>ch</u>oir and [tʃ] for <u>ch</u>ild) and several graphemes may represent a single phoneme (e.g., EA as in <u>ea</u>sy and EE as in bl<u>ee</u>d for [iː]). In addition, the complexity of phoneme-grapheme mappings may differ across reading and spelling. Whereas there is typically one possible phonetic reading of an English word using GPC, there are multiple possible phonetic spellings of an English word using PGC, suggesting an asymmetry between GPC and PGC (Sprenger-Charolles, Siegel & Bonnet, 1998; Stanovich, 1991). In order to correctly spell a word, a child must first segment the word into its individual phonemes and then decide which graphemes adequately represent these phonemes. Even more perplexing are the irregular words in which applying phoneme-grapheme rules actually result in an incorrect spelling (e.g., [məræŋ] - meringue). Hence, accessibility of the mental lexicon, or lexical access, is also important in spelling. However, there is much more to spelling than rote memory. Children with developed phonological and orthographic awareness will look for cues within the word to help them with this grapheme selection process. The first cue is the position of the phoneme within the word and the second cue is the neighbouring phoneme(s).

In the present study, Persian L1 and English L1 speakers (alphabetic orthography) are compared to Chinese L1 speakers (nonalphabetic orthography) to examine the effects of grapheme-phoneme mapping experience in learning English as a second language.

Persian: A non-Roman alphabetic language

Persian is an alphabetic language with predictable GPC (i.e., a shallow orthography). Persian is a modified version of Arabic, with the letters written from right to left. There are 29 letters representing consonants and three letters representing long vowels (*alef*, *vav*, *ye*), as shown in Figure 1. The three short vowels are represented by diacritics, not letters. The diacritics appear above or below the letter associated with the short vowel sound (e.g., بَ, بِ). However, diacritics are used only with beginning readers and are later omitted. Whereas in English, the visual form of each letter remains constant regardless of position within the word, in Persian, the visual form of each letter varies slightly depending on its position in the word. The letters in Figure 1 are in their detached forms. Similar to English, a single Persian phoneme can be represented by several graphemes.

ذ	د	خ	ح	چ	ج	ث	ت	پ	ب	ا
z̤āl	dāl	khe	he	che	jīm	s̱e	te	pe	be	alef
غ	ع	ظ	ط	ض	ص	ش	س	ژ	ز	ر
ghain	'ain	zā	tā	zād	sād	shīn	sīn	zhe	ze	re
ی	ه	و	ن	م	ل	گ	ک	ق	ف	
ye	he	vāv	nūn	mīm	lām	gāf	kāf	qāf	fe	

Figure 1. *Persian Alphabet Letters.* The English translation for the names of the letters appear under each Persian character.

Chinese: A nonalphabetic language

Although grapheme-phoneme correspondences do not apply in nonalphabetic languages, phonological processing is still important for learning to read and spell. For instance, the Chinese script was long believed to be completely logographic (visual), and the contributions of phonology to the learning of Chinese received little attention. Recent research has shown that the Chinese language is more phonetic and less visually based than initially believed, although the available phonetic information is much more imprecise than in alphabetic languages (e.g., Jackson, Chen, Goldsberry, Ahyoung,& Vanderwerff, 1999; Tan & Perfetti, 1998). The phonological information is represented at the level of the syllable rather than the phoneme (Leong, 1997; Perfetti & Zhang, 1995). As such, the Chinese script has been described as morphosyllabic because each Chinese character is a morpheme as well as a syllable. Approximately 80% of Chinese characters are phonetic compounds that have a semantic radical to provide meaning and a phonetic component to guide pronunciation (Chan & Siegel, 2001; Huang & Hanley, 1995). However, the phonetic component guides pronunciation only about 40% of the time. Given the unreliability of phonetic information, other strategies may become particularly salient for reading and spelling, such as memory for the visual word form

(Huang & Hanley, 1994). Figure 2 presents an example of how phonetic and semantic components are combined into phonetic compounds.

		Phonetic Component				
		古 gŭ	扁 biăn	敖 aó	旁 páng	堯 yāo
Semantic Radical	人 (person)	估 gŭ (to guess)	偏 piān (biased)	傲 ào (proud)	傍 bāng (beside)	僥 jiào (lucky)
	言 (words)	詁 gŭ (commentaries)	諞 pián (to quibble)	謷 áo (to slander)	謗 bàng (to libel)	譊 náo (to argue)
	虫 (insect)	蛄 gū (mole cricket)	蝙 biān (bat)	螯 áo (crab's pincers)	螃 páng (crab)	蟯 ráo (worm)
	金 (metal)	鈷 gū (cobalt)		鏊 áo (griddle)	鎊 bàng (pound sterling)	鐃 náo (cymbals)

Figure 2. *Example of phonetic compounds.* Figure adapted from www.omniglot.com.

Cross-linguistic theories of literacy acquisition

Two major theoretical positions underlie second language literacy research. The universalist hypothesis, or linguistic-interdependence hypothesis, proposes that the development of literacy skills in different languages are shaped by common underlying cognitive and linguistic processes (Cummins, 1979). Hence, skills learned in the first language will readily transfer to the learning of a second language. Evidence supporting the universalist perspective comes from a variety of studies. For instance, Durgunoglu, Nagy and Hancin-Bhatt (1993) found that L1 phonological awareness and L1 word recognition were predictive of English word reading performance in a group of first-grade Spanish L1 speaking students learning to read in English. Also according to the universalist perspective, children with difficulties in the processes involved with literacy acquisition in the first language should show the same difficulties in the second language. In a study of bilingual Portuguese-English speaking children, Da Fontoura and Siegel (1995) found that there was a significant relationship between the acquisition of word reading, decoding, working memory and syntactic awareness in the two languages. Furthermore, the bilingual children who had lower reading scores in one language also had lower reading scores in the other language.

The script-dependent hypothesis posits that the success in learning to read and spell in a second language is significantly influenced by the differences between the two orthographies, such as shallow vs. deep, or alphabetic vs. nonalphabetic. However, having L1 effects on second language literacy does not imply that second language processes are adversely affected. Rather, it suggests that there may be qualitative differences in the skills or strategies that underlie second language literacy processes and that these differences may be due to differences in orthographic elements of the L1. Similarly, the script-dependent perspective has also received some support (e.g., Ryan & Meara, 1991; Wang, Koda, & Perfetti, 2003). Using visual word shape distortion in reading (e.g., cAsE aLtErNaTiOn), Akatmatsu (1999, 2003) demonstrated that the differences in the alphabetic sensitivity of fluent ESL adult readers could be attributed to whether the L1 orthography was alphabetic (Persian L1) or nonalphabetic (Chinese and Japanese L1). The Persian L1 readers were more successful than the Chinese and Japanese L1 readers in reading case alternated words in isolation (Akatmatsu, 1999) and in reading case alternated words in passages (Akatmatsu, 2003), suggesting that the Persian L1 readers were more efficient at preserving the spelling of patterns, despite visual shape distortion, to come to a correct reading of the word. Also, in a study of Chinese ESL children, Wang and Geva (2003) found that although Chinese L1 children were less accurate at spelling pseudowords than English L1 children, they were better at determining legitimate and illegitimate letter strings. The authors concluded that the Chinese L1 children were more likely to use visual, holistic information based on orthographic patterns rather than the phonological strategy used by their English L1 peers.

The cognitive processes of literacy

This study is based on a model of reading that postulates three cognitive processes – phonological processing, syntactic awareness and working memory – that are significant in the development of English literacy skills (for a review see Siegel, 1993). The influences of these three processes are so robust that many psycho-educational assessments for children at-risk for learning disabilities typically assess some or all of these processes (e.g., Scanlon & Vellutino, 1997).

Phonological processing

Phonological processing loosely refers to a variety of skills involving the processing of speech sounds. It is well established that phonological processing plays an important role in the early reading acquisition for native speakers of many languages, ranging from English (Perfetti, 1985) to Spanish (Durgunoglu, Nagy, & Hancin-Bhatt, 1993) to Dutch (Patel, Snowling, & de Jong, 2004) to Chinese (Tan & Perfetti, 1998). In fact, core deficits in phonological processing are associated with persistent difficulties in the acquisition of reading skills (for a review see Siegel, 1993). Of interest in the current study is phonological awareness, or the ability to discriminate and manipulate the sounds of the language. Phonological awareness is measured through a variety of techniques, including rhyming, segmenting sounds, blending sounds and deleting sounds (Yopp, 1988). A related skill is phonological decoding, or the application of grapheme-phoneme correspondences. Whereas, phonological awareness refers to an oral language skill, phonological decoding refers to the association of phonological sounds to print. Phonological decoding is measured by the accuracy of pronouncing increasingly difficult pseudowords. That is, made-up words that can be correctly read using grapheme-phoneme correspondences. Where the rate of decoding is measured, this is called phonological decoding efficiency (Perfetti, 1985). Phonological decoding difficulties are also implicated in reading disability (Da Fontoura & Siegel, 1995; Geva & Siegel, 2000).

ESL speakers, by definition, have delayed exposure to the phonological structures of the English language compared to English L1 speakers. Yet, ESL speakers are not necessarily at a disadvantage in gaining early English literacy skills (Lesaux & Siegel, 2003). Phonological processing skills learned in the first language can be relatively strong predictors of concurrent and subsequent literacy skills in the second language regardless of orthographic differences between languages (Campbell & Sais, 1995; Chow, McBride-Chang, & Burgess, 2005; Gottardo, Yan, Siegel, & Wade-Woolley, 2001). However, studies show that the similarities between the L1 language and English may influence cross-linguistic transfer (e.g., Bialystok, Majumder, & Martin, 2003).

Syntactic awareness

In addition to phonological processing, syntactic awareness is a significant cognitive correlate of reading and spelling acquisition in the English language (Plaza & Cohen, 2004). Syntactic awareness, or grammatical sensitivity, refers to the ability to understand the way in which linguistic elements of a specific language are put together to form grammatically correct words and phrases. In studies of ESL children, both L1 and English syntactic skills were found to be significantly correlated with reading skills across languages (e.g, Portuguese - Da Fontoura & Siegel, 1995; Hebrew - Geva & Siegel, 2000; Arabic - Abu-Rabia & Siegel, 2002). Likewise, syntactic awareness is also a strong predictor of spelling performance (Juul, 2005; Muter & Snowling, 1997).

Working memory

Working memory refers to the ability to hold information in short-term storage, while transforming or manipulating it in some way. According to Baddeley and Hitch (1974), working memory consist of three components. The central executive is a limited capacity attentional system responsible for the coordination of information from two subsidiary storage systems: the visualspatial sketchpad and the phonological loop. The visualspatial sketchpad temporarily stores visual and/or spatial information and the phonological loop stores phonological or linguistic information. Working memory is vital for encoding and decoding words using grapheme-phoneme correspondences, while retrieving information about syntax and semantics. Moreover, certain tasks place greater demands on working memory than others. For instance, spelling an unfamiliar or made up word requires first the segmentation of the orally dictated word into its individual phonemes, then the selection among several possible grapheme, and finally the application of orthographic knowledge of positional constraints. All of this occurs simultaneously in working memory.

The present study

ESL speakers from alphabetic and nonalphabetic orthographies present a unique opportunity to examine whether the transfer of skills from the first language to the second language learning differ according to the degree in which the L1 adheres to the alphabetic principle. The focus of the present study was on monolingual English L1 speakers and two groups of ESL speakers: Persian L1 (non-Roman alphabetic), and Chinese L1 (nonalphabetic, morphosyllabic).

This study was guided by the following four research questions: (1) What is the relationship between measures of reading and spelling for children with diverse linguistic backgrounds? (2) What is the overall achievement of ESL children compared to English L1 children on measures of reading, spelling, and related skills? (3) Does achievement, or various aspects of achievement, vary by L1 orthographic background? and (4) What are the influences of reading and decoding fluency, phonological processing, syntactic awareness and working memory on spelling achievement.

According to the universalist hypothesis, if learning to read and spell in a second language involves processes that are shared across languages, then ESL speakers will benefit from cross-language transfer and show patterns of reading and spelling that are similar to English L1 speakers. Meanwhile, the script-dependent hypothesis would suggest that the orthographic differences in children's linguistic backgrounds would lead to differences in the processes and outcomes for reading and spelling.

Method

Participants

The participants were 122 third-grade children (63 males and 59 females) from 25 schools in a single school district in Canada. The mean age of the children was 8.88 years (SD = 0.32). The children in this study were part of a larger longitudinal study that began in their kindergarten year.

The participants were classified as ESL if they spoke a language other than English at home to parents, siblings and grandparents. Within the sample, there were 45 English L1 speakers and 77 ESL speakers (32 Persian L1 and 45 Chinese L1). Among the Chinese L1 speakers, 14 were Mandarin speakers, 18 were Cantonese speakers and 13 were speakers of an alternate Chinese dialect. Most of the ESL speakers immigrated to Canada at an early age, although some were born in Canada and did not begin to speak English until school entry. All of the ESL speakers in this study have had at least two years of full-time English classroom instruction, with the children receiving schooling in English since kindergarten. ESL students within the school district received the same classroom instruction as their English L1 speaking peers. As the sample represented an entire school district, the participants also represented a wide range of socioeconomic status (SES) backgrounds.

Design

The ESL participants were normally-achieving readers and spellers who scored above the 25th percentile on the Spelling and Reading subtests of the Wide Range Achievement Test – Third Edition (WRAT3; Wilkinson, 1993). All participants scoring under the 25th percentile were excluded. The scores for the ESL participants ranged from the 32nd to 99th percentile on both the Reading and Spelling subtests of the WRAT3. These scores were used to select a comparably matched English L1 group. The English L1 speakers were randomly selected from the same classrooms as the ESL speakers. To be included in the English L1 comparison group, the English L1 speakers also needed to have both reading and spelling scores that fell within the 32nd to 99th percentile on the WRAT3 Reading and Spelling subtests. The group characteristics are summarized in Table 1.

Table 1. *Details of Group Characteristics by First Language*

	English L1 (n=45)	Persian L1 (n=32)	Chinese L1 (n=45)
WRAT3 reading percentile			
Minimum Value	32	37	32
Maximum Value	99	98	99
WRAT3 spelling percentile			
Minimum Value	32	32	39
Maximum Value	99	99	99
Chronological age (years)			
M	8.90	8.90	8.84
SD	.34	.28	.32
Gender			
Male	24	13	26
Female	21	19	19

Measures

Word recognition

Wide Range Achievement Test-3: Reading Subtest (blue form; Wilkinson, 1993). The reading subtest is a standardized, individually administered measure of word recognition. The child was asked to read as many words as possible from a list of words of increasing difficulty. Administration was discontinued when ten consecutive errors were made. Sample words include: *cat, tree, collapse.*

Woodcock Reading Mastery Test – Revised (Form G): Word Identification (Woodcock, 1987). The Word Identification subtest is a standardized, individually administered measure of word recognition. The child was asked to read aloud a list of words of increasing difficulty. Administration was discontinued when all items on a given level were failed. Sample words include: *as, must, whole.*

One-minute word reading. The ease and speed of single word reading was assessed by asking each child to read as many words as possible from a list of words within a one-minute time period. The words were from the WRAT3 Reading subtest (tan form; Wilkinson, 1993). Standardized norms are not available when the list is used as a timed task. Sample words include: *see, then, cliff.* The maximum score on this task was 42.

Phonological decoding

Woodcock Reading Mastery Test – Revised (Form G): Word Attack (Woodcock, 1987). The Word Attack subtest is a standardized measure of phonological decoding, or the application of grapheme-phoneme correspondences. The child was asked to read aloud a list of pseudowords of increasingly difficulty. Administration was discontinued when all items on a given level were failed. Sample words include: *tiff, zoop, snirk.*

One-minute pseudoword reading The ease and speed of decoding was assessed by asking each child to read as many pseudowords as possible within a one-minute time period. The pseudowords were from the WRMT-R Word Attack Subtest (Form H; Woodcock, 1987).Standardized norms are not available when the list is used as a timed task. Sample words include: *ip, yee, dreek.* The maximum score on this task was 45.

Spelling

Wide Range Achievement Test-3: Spelling Subtest (blue form; Wilkinson, 1993). The spelling subtest is a standardized measure of single word spelling. The child was asked to spell dictated words of increasing difficulty. Sample words include: *and, must, explain.*

Pseudoword spelling. On the WRAT-3 spelling dictation test, the child could correctly spell a word either using memory, knowledge of phonetics, or a combination of both. In order to isolate the child's skill in applying phoneme-grapheme correspondences to spell, the child was asked to generate plausible spellings of orally presented pseudowords. Fifteen pseudowords were selected from the GFW Sound-Symbol Tests – Spelling Test (Goldman, Fristoe & Woodcock, 1974). Standardized norms are not available with the reduced list. Sample items include: *nad, jesh, shenning*. The pseudowords are listed in Appendix A.

Phonological awareness

Rosner's Auditory Analysis Test (Rosner & Simon, 1971). The child was asked to say a word and then to say the word again either without one of its syllables (e.g. "Say carpet", "Now say carpet without the /car/) or without one of its phonemes (e.g. "Say smell", "Now say smell without the /m/ sound"). The child was asked to delete syllables and phonemes from the initial, middle and final positions in words. There were 40 items arranged in order of difficulty. Administration was discontinued when five consecutive errors were made. The maximum score on this task was 40.

Working memory

Working Memory for Words (Siegel & Ryan, 1989). The child was orally presented with a set of sentences missing the final words and was asked to provide the missing word to complete each sentence. To minimize word finding, the sentences were chosen so that the final word was virtually predetermined. The child was then asked to repeat words that s/he provided for the end of each sentence, in order. The number of sentences in each set increased, beginning with two sentences and increasing by an additional sentence, up to a possible five sentences (2, 3, 4, 5). Sample sentences include: *"Running is fast, walking is ___. At the library people read ___. An apple is red, a banana is ___."* Administration was discontinued when all items on a given level were failed. The maximum score on this task was 12. The sentences are listed in Appendix B.

Working Memory for Numbers (Siegel & Ryan, 1989). The child was presented with sets of index cards with a random array of blue and yellow dots. For each set, the child was asked to count the number of yellow dots on each card and then recall the number of dots counted in each set in sequence. There were three trials within each set of cards. The number of cards in each set increased, beginning with two cards and increasing by an additional card, up to a possible five cards (2, 3, 4, 5). Administration was discontinued when all items on a given level were failed. The maximum score on this task was 12.

Syntactic awareness

Oral Cloze (Siegel & Ryan, 1989; Willows & Ryan, 1986). Syntactic awareness was assessed using an oral cloze procedure. Eleven sentences were read to the child, and the child was asked to provide the missing word in each sentence. In order for the response to be considered correct, the addition of the word must form a semantically and syntactically correct sentence. Sample sentences include: *"Betty ___ a hole with her shovel", "Jane ___ her sister ran up the hill"*, and *"Dad ___ Bobby a letter several weeks ago".* The Oral Cloze sentences are listed in Appendix C.

Procedure

Each child was individually assessed in a quiet room in one session. The WRAT3 Spelling task was administered in a group setting.

The research team consisted of trained graduate and undergraduate students from the areas of education and psychology. The examiners were thoroughly trained on all measures prior to the data collection process. Supervision was provided by designated research team leaders. Further quality monitoring included the reviewing of protocols for accuracy and completeness during the data collection process and reviewing the accuracy of scores during the data entry process.

Spelling error classification

Spelling development in English has been described in three main (and up to five) phases (Ehri, 1989). During the precommunicative (logographic) phase, children understand that spoken sounds can be represented as print, but their spelling bears no resemblance to the actually target words. For instance, they may represent a word by a scribble or a random string of letters and/or numbers. During the phonetic (alphabetic) phase, children start to represent only one or two of the salient sounds in a word, such as the first and last consonants (BK for bake, HT for heat). Then the representation of vowel sounds becomes more prevalent when children sequentially sound-out spelling words and then represent each separate sound with a corresponding letter (e.g., BAK for bake, HET for heat). During this phase, children's knowledge of phonological and rule-based spelling grows substantially (Ehri, 1989). In the subsequent phase, the morphemic (orthographic) phase, orthographic and morphemic knowledge guide spelling (e.g., knowing that long vowels can be spelled with a silent-e ending as in heat spelled HETE). Hence, transiting from a phonetic to an orthographic strategy requires the abandonment of the "one letter for one sound" rule (Drake & Ehri, 1984). Although children generally progress through a series of phases in spelling development, the differences in phases are better described as the shift in use of predominant strategies rather than discrete stages (Caravolas, 2004).

Generally, normative-referenced standardized tests and criterion-referenced classroom tests of spelling are scored as either correct or incorrect. Although misspellings lack complete accuracy, they are not without value and can still hold some degree of accuracy. Misspelling error analysis provides a window into the strategies used when a child encounters spelling challenges. If the skills developed in the L1 transfer to second language learning, then the extent to which ESL spelling shows reliance on particular strategies could be expected to vary with whether their native language is a non-Roman alphabet, such as Persian, or a nonalphabet, such as Chinese. In this study, the first 10 spelling errors on the WRAT-3 spelling subtest for each subject were analyzed. Three scores were constructed for each misspelling based on a system similarly used by Lennox & Siegel (1996).

Phonemic Accuracy and Phonetic Plausibility. Two of the scores were based on the phonological similarity of the misspelling to the target word.

Phonemic Accuracy refers to the number of phonemes correctly represented in the misspelling. For instance, the word “brief” has four phonemes ([b] [r] [iː] [f]). The item misspelled as BREFE receives a full score of 100% because all of the phonemes are represented, although the spelling is incorrect. Whereas, the word misspelled as BRF or BREF receives a score of 75% as only three phonemes are correctly represented. The letter E in BREF is not considered phonemically accurate according to this scoring system because a vowel digraph (e.g., BREEF, BREAF) or a silent-e ending (e.g., BREFE) is required for the long “e” sound. It was also permissible for words to be orthographically illegal (e.g., CKWANTITY for “quantity”). For each child, the Phonemic Accuracy scores calculated for the 10 misspellings were summed and divided by 10 to yield an average score per child.

Phonetic Plausibility refers to whether the misspelling sounds identical to the target word when read according to grapheme-phoneme correspondences. Correct responses in the Phonetic Plausibility category require accurate representations of all phonemes in their correct positions. As such, each phonetic plausible misspelling is also a 100% phonemically accurate misspelling (e.g., BREFE). Each misspelling received a score of “0/incorrect” or “1/correct”. For each child, the Phonetic Plausibility scores calculated for the 10 misspellings were summed and divided by 10 to yield an average score per child.

A measure of inter-rater agreement was calculated for the phonological similarity scores by comparing the ratings between two independent raters. Any disagreements among the scoring of items were resolved through discussion. The inter-rater agreement was 90% for the Phonemic Accuracy scores and 98% for the Phonetic Plausibility scores.

Visual Similarity. The *Visual Similarity* score reflects the amount of visual overlap between the letters in the misspelling and in the target word. The Visual Similarity score takes into consideration the percentage of correctly sequence letters (percentage of bigrams) and the number of correctly represented letters. For instance, the word "brief" has four bigrams (b-r, r-i, i-e, e-f) and five letters, resulting in a total possible score of nine. The misspelling BREF has two correct bigrams (i.e, b-r and e-f) and four correct letters, resulting in a score of six. The misspelling would then receive a score of six out of nine, or a Visual Similarity score of 67%. For each child, the Visual Similarity scores calculated for the 10 misspellings were summed and divided by 10 to yield an average score per child.

Most of the English consonants have regular reading and spelling correspondences, although there are a handful of variations. For instance, most consonant letters correspond to only one sound (e.g., D, M, P, T). A few consonant letters can correspond to one sound or be silent (e.g., <u>b</u>ad/ bom<u>b</u>, <u>h</u>e/<u>h</u>our, <u>k</u>it/<u>k</u>nee) or correspond to more than one sound (e.g., <u>c</u>at/<u>c</u>ell/<u>c</u>ello, <u>g</u>o/ca<u>g</u>e). Some combinations of letters represent one sound (e.g., pi<u>ck</u>, gra<u>ph</u>eme, wa<u>tch</u>), whereas some combinations of letters represent two possible sounds (e.g., <u>ch</u>oice /<u>ch</u>oir). The vowels, however, vary depending on the position of the vowel within the word, as well as the morphemic and syllabic structure of the word. To be consistent, a list of rules was constructed to aid in the pronunciation of the consonants and vowels in the misspellings (see Appendices D and E).

Results

What is the relationship between reading and spelling performance for children with diverse linguistic backgrounds?

Table 2 presents the Pearson product-moment correlations among spelling and word reading measures, with $r = .10$ being a small effect size, .30 being medium, and .50 being large (Cohen, 1992). Both English L1 and ESL speakers showed correlations of comparable magnitude between measures of word recognition and WRAT3 spelling: *r*'s ranging from .57 to .65 for English speakers, .45 to .64 for Persian speakers and .58 to .71 for Chinese speakers. Hence, real word spelling accuracy is not only related to the formation of lexical entries and the fluency of lexical access (i.e., WRAT3 Reading, Word Identification, one-minute word reading), but also with the proficiency and fluency of applying grapheme-phoneme correspondences (i.e., Word Attack, one-minute pseudoword reading).

Table 2. *Pearson Product-Moment Correlations Between Reading and Spelling*

	1.	2.	3.	4.	5.	6.
ENGLISH						
1. WRAT3 Reading	____					
2. WRMT-R Word Identification	.74***	____				
3. One-minute reading	.65***	.65***	____			
4. WRMT-R Word Attack	.57***	.56***	.49***	____		
5. One-minute pseudoword reading	.66***	.68***	.72***	.61***	____	
6. WRAT3 Spelling	.65***	.60***	.57***	.61**	.57***	____
7. Pseudoword spelling	.56***	.47***	.50***	.35*	.44**	.32*
PERSIAN						
1. WRAT3 Reading	____					
2. WRMT-R Word Identification	.64***	____				
3. One-minute reading	.37*	.58***	____			
4. WRMT-R Word Attack	.54**	.55***	.34	____		
5. One-minute pseudoword reading	.38*	.56***	.64***	.59***	____	
6. WRAT3 Spelling	.47**	.64***	.54***	.45**	.51**	____
7. Pseudoword spelling	.54**	.35	.42*	.42*	.31	.47**
CHINESE						
1. WRAT3 Reading	____					
2. WRMT-R Word Identification	.74***	____				
3. One-minute reading	.60***	.50***	____			
4. WRMT-R Word Attack	.68***	.80***	.51***	____		
5. One-minute pseudoword reading	.70***	.63***	.63***	.78***	____	
6. WRAT3 Spelling	.71***	.58***	.62***	.65***	.69***	____
7. Pseudoword spelling	.30	.22	.34*	.29	.40**	.12

* $p < 0.05$ level (2-tailed), ** $p < 0.01$ level (2-tailed), *** $p < 0.001$ level (2-tailed)

WRAT3 = Wide Range Achievement Test (3rd Ed.)
WRMT-R = Woodcock Reading Mastery Test – Revised

Does reading performance vary by L1 language background?

Group differences on all measures were examined using a series of one-way analysis of variance (ANOVA). To control for type I error, the alpha level was set at .01. Eta-squared (η^2) was used as a measure of effect size. Table 3 summarizes the performance of the three language groups on the word recognition and decoding tasks. There were no significant differences between the L1 language groups on any of the word recognition tasks: WRAT3 reading subtest, $F(2, 119) = .03$, *ns*, $\eta^2 = .00$, Word Identification, $F(2, 119) = .30$, *ns*, $\eta^2 = .01$, one-minute word reading task, $F(2, 119) = .30$, *ns*, $\eta^2 = .01$, Word Attack $F(2, 119) = .61$, *ns*, $\eta^2 = .01$, and one-minute pseudoword reading task, Welch F^1 (2, 79.02) = .57, *ns*, $\eta^2 = .01$.

Table 3. *Mean Scores on Reading and Decoding Measures by First Language*

	English L1 (n=45)	Persian L1 (n=32)	Chinese L1 (n=45)
WRAT3 reading percentile			
M	78.87	78.16	78.04
SD	17.94	16.94	18.04
WRMT-R Word Identification percentile			
M	83.98	82.47	85.47
SD	17.19	18.36	15.26
One-minute word reading (max. 42)			
M	19.38	19.41	20.02
SD	4.56	3.50	4.78
WRMT-R Word Attack percentile			
M	77.60	82.81	78.69
SD	22.32	19.93	20.77
One-minute pseudoword (max. 45)			
M	30.27	30.44	28.91
SD	6.81	4.38	8.28

WRAT3 = Wide Range Achievement Test (3rd Ed.)
WRMT-R = Woodcock Reading Mastery Test - Revised

[1] Due to heterogeneity of variances, the Welch F-ratio is reported for one-minute pseudoword reading.

Does spelling performance vary by L1 language background?

The performance of the language groups on measures of spelling are shown in Table 4. Although there were no significant differences between the language groups on the WRAT3 Spelling subtest, F (2, 119) = 1.47, *ns*, η^2 = .02, there was a significant effect of L1 language on the pseudoword spelling task F (2, 119) = 5.56, p < .01, η^2 = .09. Post hoc Tukey HSD pairwise comparisons revealed that while there was no difference between the two alphabetic L1 groups (English, Persian) and no difference between the two ESL groups (Persian, Chinese), the Chinese L1 group was less accurate than the English L1 group at spelling pseudowords (p < .01).

Table 4. *Mean Scores on Spelling Measures by First Language*

	English L1 (n=45)	Persian L1 (n=32)	Chinese L1 (n=45)	Post Hoc
WRAT3 spelling percentile				
M	69.73	69.94	76.38	
SD	21.79	21.23	18.24	
Pseudoword spelling (max. 15)				
M	10.13	9.56	8.09	E = P
SD	2.61	3.02	3.30	P = C
				C < E *

* p < .01

WRAT3 = Wide Range Achievement Test (3^{rd} Ed.)

In order to examine the influences of L1 spelling strategies on English spelling, the three categories of spelling errors were also analyzed using a series of one-way ANOVAs. The performance of the language groups is shown in Table 5. Although the results of the Phonemic Accuracy scores revealed that the three language groups were comparably successful at correctly representing the individual phonemes within the misspellings, F (2, 119) = 3.64, *ns*, η^2 = .06, the three language groups differed on generating misspellings with Phonetic Plausibility at the word level F (2, 119) = 12.94, p <. 001, η^2 = .18. Post hoc Tukey HSD comparisons revealed that the nonalphabetic Chinese L1 group was less proficient than the two alphabetic groups at generating phonetically plausible misspellings that can be read to sound like the target word (English, $p < .001$; Persian, $p < .01$).

In terms of Visual Similarity, the results of the ANOVA revealed that the three language groups did not differ in their accuracy at representing the target letters within the misspellings. The amount of visual overlap between the misspellings and the target spellings were similar across the three language groups, $F\ (2, 119) = .497$, *ns,* $\eta^2 = .01$.

Table 5. *Spelling Error Analyses for WRAT3 Spelling by First Language*

	English (n=45)	Persian (n=32)	Chinese (n=45)	Post Hoc
Phonemic Accuracy				
M	87.99	86.12	84.11	
SD	7.45	6.73	6.22	
Phonetic Plausibility				
M	44.67	39.06	24.44	E = P
SD	19.26	17.66	20.51	P > C *
				C < E **
Visual Similarity				
M	67.29	65.70	66.72	
SD	7.24	6.20	7.13	

* $p < .01$, ** $p < .001$

Does phonological awareness, working memory and syntactic awareness vary by L1 language background?

Table 6 summarizes the performance of the three language groups on measures of phonological awareness, working memory and syntactic awareness. The ANOVA results revealed no significant differences between the language groups on Rosner's Auditory Analysis Test, $F\ (2, 119) = .03$, *ns,* $\eta^2 = .00$, Working Memory for Words, $F\ (2, 119) = .90$, *ns*, $\eta^2 = .02$, as well as on Working Memory for Numbers, $F\ (2, 119) = .149$, *ns,* $\eta^2 = .00$. The groups, however, differed on Oral Cloze, $F\ (2, 119) = 11.95$, $p < .001$, $\eta^2 = .17$. Results of Tukey HSD post hoc comparisons indicated that the nonalphabetic Chinese L1 speakers produced fewer semantically and syntactically correct phrases through an oral cloze procedure than the two alphabetic L1 groups (English L1, p <.001; Persian L1, p < .01). The performance between the two alphabetic L1 groups did not significantly differ.

Table 6. *Mean Scores on Phonological Awareness, Working Memory and Syntactic Awareness by First Language*

	English (n=45)	Persian (n=32)	Chinese (n=45)	Post Hoc
Rosner's AAT (max. 40)				
M	29.89	29.78	29.49	
SD	8.50	6.22	7.50	
Working Memory Words (max. 12)				
M	4.76	4.25	4.40	
SD	1.60	1.83	1.79	
Working Memory Numbers (max. 12)				
M	7.96	7.69	7.87	
SD	2.30	2.10	1.99	
Oral Cloze (max. 11)				
M	8.27	7.91	6.49	E = P
SD	1.70	1.77	1.93	P > C *
				C < E **

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

What are the contributions of reading and decoding fluency, phonological awareness, working memory and syntactic awareness to spelling performance?

Linear multiple regression was used to determine the relative contributions of reading and decoding fluency, phonological awareness, working memory and syntactic awareness to WRAT3 Spelling performance. Separate models were constructed for the English, Persian and Chinese L1 speakers with the WRAT3 Spelling entered as the dependent variable and one-minute word reading, one-minute pseudoword reading, Rosner's AAT, Working Memory for Words, Working Memory for Numbers and Oral Cloze simultaneously entered as explanatory variables. These explanatory variables were selected for entry into the model based on the theoretical relationship between each of these variables and reading development for L1 and ESL children (e.g., Siegel, 1993, 2004).

All models were statistically significant. Scatterplots show that each explanatory variable was generally linearly related to WRAT3 Spelling. A histogram of the standardized residuals, and the Normal P-P plot showed that the residuals were approximately normally distributed. A boxplot of the residuals showed no existence of outliers. A scatterplot of each explanatory variable against the residuals showed no major departures from homoskedasticity. One child with a lever value of .65 was removed from the Persian regression model. According to Huber's (1981) guideline, a lever with a value of .50 and above should be avoided if possible as the particular observation is placing too much influence on the regression line. Hence, the final Persian model consisted of 31 subjects. The maximum leverage values for the resulting models were within the acceptable range, according to Huber's (1981) criterion, (English = .24; Persian = .47; Chinese = .35). Although the independent variables were correlated, the values for the Variable Inflation Factor were adequate (English: 1.53 – 2.80; Persian: 1.41 – 3.56; Chinese: 1.04 – 2.06), as were the values for tolerance (English: .36 - .66; Persian: .28 - .71; Chinese: .49 - .96). Cohen's f^2 criterion was used as a measure of effect size, with .02 being small, .15 being medium, and .35 being large (Cohen, 1992).

The Pratt Index was used to examine the relative contribution of each explanatory variable in the model by partitioning the proportion of the overall R^2 to each explanatory variable (Thomas, Hughes, & Zumbo, 1998).

As summarized in Table 7, the model accounted for approximately 49% of the variance in the English speaker's WRAT3 Spelling performance, $F(6, 38) = 6.09$, $p < .001$, $f^2 = .96$. One-minute word reading accounted for the largest proportion of variance accounted for by the model (41.0% of the R^2), followed by Working Memory for Numbers (33.7%) and Oral Cloze (13.2% of the R^2). The contributions of one-minute pseudoword reading, Rosner's AAT and

Working Memory for Words to the model was considered "unimportant" as the relative Pratt Index was smaller than the criterion index value (Thomas, 1992).

Table 7. *Pratt Indices for WRAT Spelling Regression Model by First Language*

	Beta-weight	Pearson Correlation with WRAT3 Spelling	Relative Pratt Index
English $R^2 = .490$			
One-minute word reading	.354	.567	.410
One-minute pseudoword reading	.069	.565	.080
Rosner's AAT	.099	.400	.081
Working Memory for Words	-.207	.097	-.041
Working Memory for Numbers	.340	.486	.337
Oral Cloze	.136	.476	.132
Persian $R^2 = .558$			
One-minute word reading	.453	.594	.482
One-minute pseudoword reading	-.017	.477	-.015
Rosner's AAT	-.053	.304	-.029
Working Memory for Words	-.003	.256	-.001
Working Memory for Numbers	.307	.295	.162
Oral Cloze	.497	.450	.401
Chinese $R^2 = .621$			
One-minute word reading	.329	.615	.326
One-minute pseudoword reading	.456	.694	.510
Rosner's AAT	-.078	.289	-.036
Working Memory for Words	-.065	.107	-.011
Working Memory for Numbers	.238	.400	.153
Oral Cloze	-.213	-.172	.059

Note: to calculate the relative Pratt Index, the Beta-weight is multiplied by the Pearson product-moment correlation. The resulting number is then divided by the R^2 for the model. A variable with a relative Pratt Index less than 1/(2 x number of explanatory variables) is considered unimportant (Thomas, 1992).

Also summarized in Table 7, the model accounted for about 56% of the variance in the Persian speaker's WRAT3 Spelling performance, F (6, 24) = 5.06, $p < .01$, $f^2 = 1.26$. One-minute word reading accounted for the largest proportion of variance accounted for by the model (48.2% of the R^2), followed by Oral Cloze (40.1%) and Working Memory for Numbers (16.2% of the R^2). Similar to the English model, the relative contributions of one-minute pseudoword reading, Rosner's AAT and Working Memory for Words to the model were considered "unimportant".

The model accounted for about 62% of the variance in the Chinese speaker's WRAT3 Spelling performance, $F(6, 38) = 10.39$, $p < .001$, $f^2 = 1.64$. The variables in order of relative contribution to the model were as follows: one-minute pseudoword reading (51.0% of the R^2), one-minute word reading (32.6% of the R^2) and Working Memory for Numbers (15.3% of the R^2). Rosner's AAT, Working Memory for Words and Oral Cloze were considered "unimportant" contributors in the model.

Discussion

The present study examined whether the orthographic features of children's L1 language influence the acquisition of reading and spelling in English as a second language. Specifically, comparing children's whose L1 language is alphabetic (i.e., English, Persian) with those whose L1 language is not alphabetic (i.e., Chinese), the study examined whether ESL speakers with a nonalphabetic L1 are less efficient at applying English grapheme-phoneme and phoneme-grapheme rules than alphabetic L1 speakers.

The first research question addressed whether the relationship between reading and spelling was similar for English L1 and ESL children from contrasting orthographies. Positive and significant correlations among spelling and reading measures revealed a significant relationship between learning to read and spell in English regardless of L1 language background.

The second and third research questions addressed the overall achievement of ESL children and whether their performance may vary as a function of the structure of their L1 language. In spite of their later exposure to the phonological structures of the English language, both groups of ESL speakers were as successful as the English L1 speakers at manipulating the sounds of the English language (i.e., phonological awareness) and at applying grapheme-phoneme mapping rules to read unfamiliar words (i.e., Word Attack) with ease and speed (one-minute pseudoword reading). In addition, the performance on word reading measures revealed that all groups had comparably well-developed word vocabulary (WRAT3 Reading and WRMT-R Word Identification) and were able to retrieve these words form memory with similar ease and speed (one-minute word reading). Hence, the findings of the reading and decoding measures suggest the positive transfer of skills from a shallow to deep alphabetic language and from a nonalphabetic to alphabetic language, providing support for the universalist hypothesis.

In terms of working memory, there were no significant differences in performance across the languages groups for working memory tasks involving either solely verbal information, or visualspatial and verbal information combined. However, syntactic awareness, or grammatical sensitivity, was influenced by L1 language experience. The nonalphabetic Chinese L1 group obtained lower scores on the Oral Cloze task than the alphabetic English and Persian L1 groups, suggesting less familiarity with English syntax. Since the Oral Cloze task can also be considered a measure of English oral language proficiency, the present study found that the Chinese L1 speakers were able to read English words better than one might expect based on their oral English skills. Similar to Geva and Siegel (2000) and Durgunoglu, Nagy and Hancin-Bhatt (1993), the present study hints to limitations in the use of second language oral proficiency in predicting the word reading skills of second language learners.

Another important finding in this study was the differential use of strategies for spelling despite similar spelling achievement across language groups. While the spelling outcomes for known "real" words (WRAT3 Spelling) did not show variations that could be attributable to L1 language experience, the use of strategies for spelling unknown words did, as summarized in Figure 3.

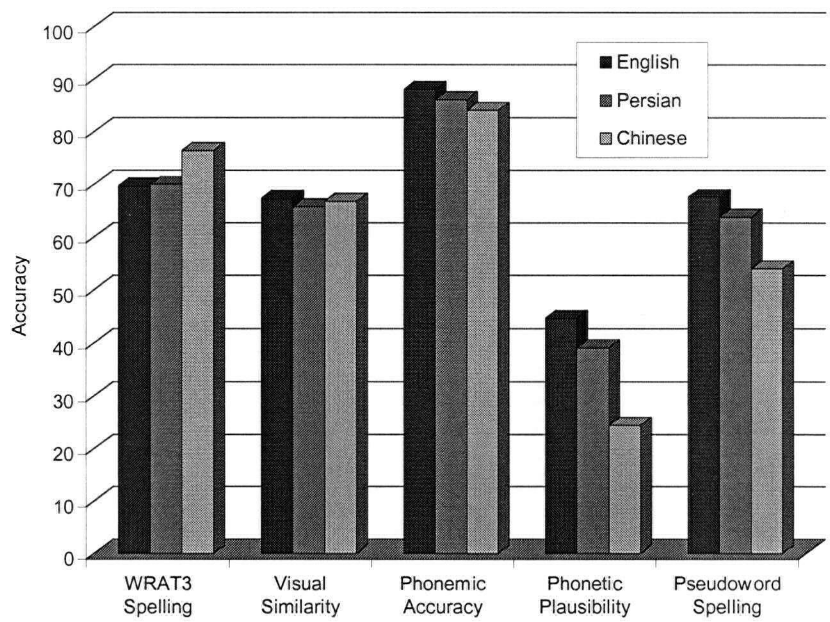

Figure 3. *Spelling Measures by First Language.* With the exception of the WRAT3 Spelling bar which represents percentile accuracy, all other bars represent percent accuracy.

The nonalphabetic Chinese group was less accurate than the English group at spelling pseudowords. Although the WRAT3 Spelling contained only real words, an "unknown" real word has no lexical entry in memory and hence, will function as a pseudoword. Accordingly, the nonalphabetic Chinese L1 group was also less likely than both alphabetic groups to generate misspellings that can be read to sound exactly like the target word (Phonetic Plausibility). The results are consistent with Wang and Geva (2003) who found that Chinese L1 children were less accurate at spelling English pseudowords than English L1 children, suggesting that Chinese L1 children were less likely than English L1 peers to use a phonological strategy to spell. Overall, there is converging evidence to indicate that grapheme-phoneme mapping experience in a child's L1 is a potential influencing factor in the use of strategies to spell in an alphabetic language, such as English.

However, the misspelling error analyses also revealed that three language groups were equally inclined to generate misspellings that resembled the target word in visual form (Visual

Similarity) and in individual phonemic units (Phonemic Accuracy). Combined, the findings of the spelling error analyses suggest that while the Chinese L1 speakers have the knowledge in applying phoneme-grapheme correspondences to represent sounds at the phonemic level, they were less efficient in applying rules in such a way as to come up with a completely phonetic misspelling. Given the visual emphasis of the Chinese script, one might expect that the Chinese L1 speakers would show a higher degree of visual accuracy in their misspellings. Yet, the present study did not find evidence for the increased use of visual strategies, as indicated by Visual Similarity scores. Although not directly tested in this study, it is plausible to suggest that the Chinese L1 speakers might be more likely to use a visual strategy to spell words that have some representation in memory. This would explain why the Chinese L1 speakers were able to spell as many real words as the alphabetic L1 speakers despite less efficiency in applying phoneme-grapheme mapping rules to spell. However, for unknown words, using a visual strategy is no longer as advantageous and they shift to a phonologically based strategy resulting in misspellings that are not more visually accurate than the alphabetic speakers.

The final research question asked whether ESL spelling could be understood by considering underlying cognitive processes deemed important for English L1 reading. Reading and decoding fluency, phonological awareness, working memory and syntactic awareness accounted for a significant amount of variance in the model for spelling performance across language groups. While there is ample evidence to suggest the importance of phonological processing, working memory and syntactic awareness English L1 and ESL word recognition (Siegel, 1993, 2004) and reading comprehension (Low & Siegel, 2005), this present study is one of the first to apply this explanatory framework to the spelling performance of ESL children with contrasting L1 orthographic backgrounds. Clearly, the findings of the present study contribute to the current literature by pointing to the robustness of reading and decoding fluency, phonological awareness, working memory and syntactic awareness as an explanatory framework for English L1 and ESL literacy skills. At the same time, there is some evidence to also suggest the relative contributions of the explanatory variables to the model of spelling varied by L1 background.

Consistent across models is the finding that verbal working memory was unimportant in terms of its relative contribution to the models. However, verbal working memory was still important to spelling performance, as evidenced by the contribution of Working Memory for Numbers to the model. Working Memory for Numbers is a measure of working memory that simultaneously involves the phonological loop and the visualspatial sketchpad, hence reflecting the sound-symbol demands involved with spelling.

Reading and phonological decoding were significant contributors to spelling in L1 and ESL speaking children, which is consistent with the findings of previous research (e.g., Arab-Moghaddam & Senechal, 2001; Wade-Woolley & Siegel, 1997). There is also large consensus that children initially spell words using predominantly phonological strategies and then proceed to using morphological and syntactic strategies (e.g., Drake & Ehri, 1984; Nunes, Bryant, & Bindman, 1997, Treiman & Bourassa, 2000). Plaza and Cohen (2004) found that phonological awareness, morphological/syntactic awareness and naming speed in first grade were significant predictors of later spelling performance in second grade. Hence, the finding in the present study that syntactic awareness was also a significant contributor to the model is consistent with current theory and research. Knowing the regularities of how different grammatical and syntactic categories are represented in the language promotes accurate spelling. Grammatical sensitivity promotes the understanding of how words are parsed into smaller units of meanings called morphemes and morphemic knowledge is highly related to spelling during the transitional or morphemic stage.

Overall, the results of regression analyses emphasize the importance of reading and decoding skills, visual-auditory working memory and grammatical sensitivity in learning to spell in English for English L1 and ESL children.

Conclusions and implications

The present study finds support for both the universalist and the linguistic inter-dependence hypothesis of second language literacy acquisition. The strategies developed in an L1 are transferred to ESL reading and spelling. Furthermore, the nature of L1 orthographic structures may have an influence on the kind of cognitive processes that are transferred to ESL reading and spelling. More specifically, while Chinese speakers with a nonalphabetic L1 have comparable word recognition skills, either by sight or application of grapheme-phoneme correspondences, they are less efficient at the application of phoneme-grapheme correspondences to spell. Yet, they are able to spell real words as accurately as alphabetic L1 speakers, suggesting the involvement of other strategies such as memory for visual word form. This is an important finding as it suggests that although there may be qualitative differences in strategies, the reading and spelling outcomes do not necessarily differ for children with diverse language backgrounds. Furthermore, the spelling outcomes for alphabetic and nonalphabetic L1 language groups can be explained by similar underlying constructs, pointing to a common model of spelling for L1 and ESL children.

This study provides suggestions for future research. For instance, measuring ESL children on literacy skills in their native languages in addition to English may provide more evidence into the cross-language transfer of meta-linguistic skills. Also, a similar study can be extended to compare ESL children with reading or spelling disability from alphabetic and nonalphabetic backgrounds.

The term "ESL", by definition, comes with it an assumption that the average ESL speaker will have less oral language proficiency than the average native English speaker. However, as with numerous other studies, this study has supported the finding that this assumption should not be readily be made about reading and writing without first considering the context of the children's first languages.

References

Abu-Rabia, S., & Siegel, L. (2002). Reading, syntactic, orthographic, and working memory skills of bilingual Arabic-English speaking Canadian children. *Journal of Psycholinguistic Research, 31*, 661-678.

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

Akatmatsu, N. (2003). The effects of first language orthographic features on second language reading in text. *Language Learning, 53*, 207-231.

Arab-Moghaddam, N., & Senechal, M. (2001). Orthographic and phonological processing skills in reading and spelling in Persian/English bilinguals. *International Journal of Behavioral Development, 25,* 140-147.

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. A. Bower (Ed.), *Recent advances in learning and motivation,* Vol. 8, (pp. 47–90). New York: Academic Press.

Bialystok, E., Majumder, S., & Martin, M.M. (2003). Developing phonological awareness: Is there a bilingual advantage? *Applied Psycholinguistics, 24,* 27-44.

Campbell, R., & Sais, E. (1995). Accelerated metalinguistic (phonological) awareness in bilingual children. *British Journal of Developmental Psychology, 13*, 61-68.

Caravolas, M. (2004). Spelling development in alphabetic writing systems: a cross-linguistic perspective. *European Psychologist, 9*, 3-14

Cassar, M., & Treiman, R. (2004). Developmental variations in spelling: Comparing typical and poor spellers. In C.A. Stone, E.R. Silliman, B.Ehren, & K. Apel (Eds.), *Handbook of Language and Literacy: Development and Disorders (Challenges in Language and Literacy)* (pp. 627 - 660). New York: Guilford Press.

Chan, C., & Siegel, L.S. (2001). Phonological processing in reading Chinese among normally achieving and poor readers. *Journal of Experimental Child Psychology, 80*, 23-43.

Chow, B.W.Y., McBride-Chang, C., & Burgess, S. (2005). Phonological processing skills and early reading abilities in Hong Kong Chinese kindergarteners learning to read English as a second language. *Journal of Educational Psychology*, 97, 81-87.

Cohen, J. (1992). A power Primer. *Psychological Bulletin, 112*, 155-159.

Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. *Review of Educational Research,* 49, 222-251.

Da Fontoura, H. A., & Siegel, L.S. (1995). Reading, syntactic and working memory skills of bilingual Portuguese-English Canadian children. *Reading and Writing: An Interdisciplinary Journal, 7*, 139 - 153.

Drake, D.A., & Ehri, L.C. (1984). Spelling acquisition: Effects of pronouncing words on memory for their spellings. *Cognition and Instruction, 1,* 297-320.

Durgunoglu, A., Nagy, W.E., & Hancin-Bhatt, B.J. (1993). Cross-language transfer of phonological awareness. *Journal of Educational Psychology. 85*, 453-465.

Ehri, L.C. (1989). The development of spelling knowledge and its role in reading acquisition and reading disability. *Journal of Learning Disabilities, 22,* 356-365.

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

Goldman R., Fristoe, M., & Woodcock, R.W.. (1974). *GFW Sound-Symbol Tests.* Circle Pines, MN: American Guidance Service, 1974.

Gottardo, A., Yan, B., Siegel, L.S., & Wade-Woolley, L. (2001). Factors related to English reading performance in children with Chinese as a first language: More evidence of cross-language transfer of phonological processing. *Journal of Educational Psychology,* 93, 530-542.

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

Huber, P.J. (1981). *Robust Statistics.* New York: Wiley.

Jackson, N., Chen, H., Goldsberry, L., Ahyoung, K., & Vanderwerff, C. (1999). Effects of variations in orthographic information on Asian and American readers' English text reading. *Reading and Writing: An Interdisciplinary Journal, 11*, 345-379.

Jarvis, S. (2000). Methodological rigor in the study of transfer: Identifying L1 influence in the interlanguage lexicon. *Language Learning, 50,* 245-309.

Juul, H. (2005). Grammatical awareness and the spelling of inflectional morphemes in Danish. *International Journal of Applied Linguistics, 15,* 87-112.

Lennox, C., & Siegel, L.S. (1996). The development of phonological rules and visual strategies in average and poor spellers. *Journal of Experimental Child Psychology, 62*(4), 60-83.

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

Lesaux, N., & Siegel, L.S. (2003). The development of reading in children who speak English as a second language. *Developmental Psychology, 39*, 1005-1019.

Low, P.B., & Siegel, L.S. (2005). *A comparison of the cognitive processes of underlying reading comprehension in native English and ESL speakers.* Unpublished manuscript.

Martin, D., & Stuart-Smith, J. (1998). Exploring bilingual children's perceptions of being bilingual and biliterate: implications for educational provision. *British Journal of Sociology of Education, 19*, 237-254.

Muter, V., & Snowling, M. (1997). Grammar and phonology predict spelling in middle childhood. *Reading and Writing: An Interdisciplinary Journal, 9,* 407-425.

Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology, 33,* 637-649.

Patel, T.K., Snowling, M.J. & de Jong, P.F. (2004). A cross-linguistic comparison of children learning to read in English and Dutch. *Journal of Educational Psychology, 96*, 785-797.

Perfetti, C. A., & Zhang, S. (1995). Very early phonological activation in Chinese reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 24–33.

Perfetti, C.A. (1985). *Reading Ability.* Oxford, England: Oxford University Press.

Plaza, M., & Cohen, H. (2004). Predictive influence of phonological processing, morphological/ syntactic skill, and naming speed on spelling performance. *Brain and Cognition, 55*, 368-373.

Rosner, J., & Simon, D. (1971). The auditory analysis test: An initial report. *Journal of Learning Disabilities, 4*, 384-392.

Ryan, A., & Meara, P. (1991). The case of the invisible vowels: Arabic speakers reading English words. *Reading in a Foreign Language, 7,* 531-540.

Scanlon, D.M., & Vellutino, F.R. (1997). A comparison of the instructional backgrounds and cognitive profiles of poor, average, and good readers who were initially identified as at risk for reading failure. *Scientific Studies of Reading, 1,* 191-215.

Siegel, L.S., & Ryan, E. (1989). The development of working memory in normally achieving and subtypes of learning disabled children. *Child Development, 60*, 973-980.

Siegel, L.S. (1993). The development of reading. In: *Advances in child development and behavior*, Vol. 24, ed. by Hayne W. Reese, 63-97. San Diego, CA, US: Academic Press.

Siegel, L. S. (2004). Bilingualism and Reading. In T. Nunes and P. Bryant (Eds). *Handbook of Children's Literacy* (pp. 673-690). Dordrecht, Netherelands: Kluwer Academic Publishers.

Sprenger-Charolles, L., Siegel, L.S., & Bonnet, P. (1998). Phonological mediation and orthographic factors in reading and spelling. *Journal of Experimental Child Psychology, 68*, 134-165.

Statistics Canada. (2001). *Profile of languages in Canada: English, French and many others,* 2001 Census. Ottawa, Ontario: Statistics Canada.

Stanovich, K.E. (1991). Changing models of reading and reading acquisition. In L. Rieben and C.A. Perfetti (Eds). *Learning to Read,* 19-32. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Tan, L.H., & Perfetti, C.A. (1998). Phonological codes as early sources of constraint in Chinese word identification: A review of current discoveries and theoretical accounts. *Reading & Writing, 10,*165-200.

Thomas, D.R. (1992). Interpreting discriminant functions: A data analytic approach. *Multivariate Behavioral Research,* 27, 335-362.

Thomas, D.R., Hughes, E., & Zumbo, B.D. (1998). On variable importance in linear regression. *Social Indicators Research: An International and Interdisciplinary Journal for Quality-of-Life Measurement, 45,* 253-275.

Treiman, R. & Bourassa, D.C. (2000). The development of spelling skill. *Topics in Language Disorders, 20*, 1-18.

Vellutino, F., Fletcher, J., Snowling, M., & Scanlon, D. (2004). Specific reading disability (dyslexia): what have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, 45*(1), 2-40.

Wade-Woolley, L., & Siegel, L.S. (1997). The spelling performance of ESL and native speakers of English as a function of reading skill. *Reading and Writing: An Interdisciplinary Journal, 9,* 387-406.

Wang, M., & Geva, E. (2003). Spelling performance of Chinese children using English as a second language: Lexical and visual-orthographic processes. *Applied Psycholinguistics, 24*, 1-25.

Wang, M., Koda, K., & Perfetti, C.A. (2003). Alphabetic and nonalphabetic L1 effects in English word identification: a comparison of Korean and Chinese English L2 learners. *Cognition, 87*, 129-149.

Wilkinson, G. (1993). The Wide Range Achievement Test - Third Edition. Lutz, FL: Psychological Assessment Resources, Inc.

Willows, D., & Ryan, E. (1986). The development of grammatical sensitivity and its relation to early reading achievement. *Reading Research Quarterly, 21*, 253-266.

Woodcock, R. (1987). Woodcock Reading Mastery Tests - Revised. Circle Pines, MN: American Guidance Service.

Yopp, H.K. (1988). The validity and reliability of phonemic awareness tests. *Reading Research Quarterly, 23*, 159-177.

Appendix A

Pseudoword Spelling

1. nad
2. gog
3. lev
4. poe, po
5. besh
6. yoy, yoi
7. jesh
8. abfim (-phim, -phym)
9. imbaf, imbaff
10. quibbest, quibest
11. wush, whush
12. ull
13. shenning
14. bofmib, boffmib
15. etbom, etbomb

Appendix B

Working Memory For Words

Instructions:

I am going to say some sentences and the last word in each sentence will be missing. I want you to tell me what you think the last word should be. Let's try one. *"For breakfast the little girl had orange ________."* Now I am going to read two sentences. After each sentence, I want you to tell me the word that should go at the end of the sentence. When I finish the two sentences, I want you to tell me the two words that you said for the end of each sentence. Please tell me the words in the order you said them. Let's try it. *"When we go swimming, we wear a bathing ________." "Cars have to stop at a red ________."*

Discontinue when the child has failed an entire level (i.e. all three items – A, B, C of a particular number)

Note: Announce each new level. Record the words in the order the child has said them.

Items

2A (1) In a baseball game, the pitcher throws the ____________.
(2) On my two hands, I have ten ____________.
Child's responses: ____________

2B (1) In the fall, we need to rake ____________.
(2) When we are sick, we often go to the ____________.
Child's responses: ____________

2C (1) An elephant is big, a mouse is ____________.
(2) A saw is used to cut ____________.
Child's responses: ____________

3A (1) Running is fast, walking is ____________.
(2) At the library, people read ____________.
(3) An apple is red, a banana is ____________.
Child's responses: ____________

3B (1) The sun shines during the day, the moon at ____________.
(2) In the spring, the farmer plows the ____________.
(3) The young child had black hair and brown ____________.
Child's responses: ____________

3C (1) In summer it is very ______________________________.
(2) People go to see monkeys in a ______________________________.
(3) With dinner, we sometimes drink ______________________________.
Child's responses: ______________________________

4A (1) Please pass the salt and ______________________________.
(2) When our hands are cold we wear ______________________________.
(3) On my way to school I mailed a ______________________________.
(4) After swimming I was soaking ______________________________.
Child's responses: ______________________________

4B (1) Snow is white, grass is ______________________________.
(2) After school, the children walked ______________________________.
(3) A bird flies, a fish ______________________________.
(4) In the barn, the farmer milked the ______________________________.
Child's responses: ______________________________

4C (1) In the autumn, the leaves fall off the ______________________________.
(2) We eat soup with a ______________________________.
(3) I go to the pool to ______________________________.
(4) We brush and comb our ______________________________.
Child's responses: ______________________________

5A (1) For the party, the girl wore a pretty pink ______________________________.
(2) Cotton is soft and rocks are ______________________________.
(3) Once a week, we wash the ______________________________.
(4) In the spring it is very ______________________________.
(5) I throw the ball up and then it comes ______________________________.
Child's responses: ______________________________

5B (1) The snail is slow, the rabbit is ______________________________.
(2) At a birthday party, we usually eat ice cream and ______________________________.
(3) Sand paper is rough but glass is ______________________________.
(4) In a garden, we pick ______________________________.
(5) Over the field, the girl rode the galloping ______________________________.
Child's responses: ______________________________

5C (1) To cut meat we use a sharp ______________________________.
(2) In the daytime it is light, and the night it is ______________________________.
(3) Dogs have four ______________________________.
(4) At the grocery store we buy ______________________________.
(5) A man is big, a baby is ______________________________.
Child's responses: ______________________________

Appendix C

Oral Cloze

Instructions: This time I will read something to you and there will be a word missing. Where the word is missing, I will say "beep". For example, I might say "The moon shines bright in the "beep." (pause and repeat) and I want you to say "sky." O.K. Let's try another one. I'll say "The children "beep" with the toys." (pause and repeat). What's the missing word? (If the child fails to respond, say "How about play? Then it would be "The children play with the toys." Let's try another one. "The little puppy wags its "beep." (pause and repeat). Good!

1. We have done the work already. We __________ it yesterday.
2. John is a good player. Bill is a better player than John. But Tom is the __________ player of them all.
3. Jane __________ her sister ran up the hill.
4. The brown dog is small; the gray dog is smaller; but the white one is the __________.
5. Betty __________ a hole with her shovel.
6. Yesterday, Tina and Marie __________ walking down the street.
7. The girl __________ is tall plays basketball well.
8. The hungry dogs have __________ all the food.
9. Jeffrey wanted to go __________ the roller coaster.
10. Dad __________ Bobby a letter several weeks ago.
11. Yesterday, Joe __________ the ball.

Appendix D

International Phonetic Association Phoneme Guide

VOWELS

[ʌ]	cup, must, blood, couple	
[e]	bet, any, said, head, friend	
[ə]	famous, ocean	(schwa) a, e, i, o, u
[ʊ]	foot, cook, wood, could, pull	
[ɪ]	explain, in, fit, system, been, build	
[æ]	cat, ash, plaid	
[i:]	easy, bleed, key, receive, achieve	
[ɑ:]	mop, job	
[u:]	loot, cruise, group	
[ɜ:]	bird	
[ɔ:]	all, law, talk, cause, broad, cough	

VOWEL DIPHTHONGS

[eɪ]	day, make, eight, tail, break, obey
[aɪ]	light, buy, die, I, my, bite, height, eye
[oʊ]	nose, boat, bone, sew, shoulder, own
[aʊ]	house, cow
[ɔɪ]	boy, coin

CONSONANTS

[b]	boy
[d]	dog
[f]	fish, phoneme, tough
[g]	get
[h]	hand
[dʒ]	job, gem, edge
[k]	kite, candy, chorus
[l]	little
[m]	mom
[n]	man, knee
[p]	pig
[r]	rain
[s]	sister, city
[t]	ten
[v]	vision
[w]	water, what
[j]	yet, yes, opinion
[z]	zebra, use
[ʒ]	vision, pleasure, regime
[ŋ]	long, rung, sing
[θ]	think, path
[ʃ]	ship, fish, station
[tʃ]	choice, watch, cello

OTHER SYMBOLS

[i] happy (long "e" sound)

[ə] schwa sound optional, as in words ending in "el", "em", "en"

e.g. label [l] [eɪ] [b] [ə] [l] can be pronounced either

by 5 phonemes [l] [eɪ] [b] [ə] [l] or

by 4 phonemes [l] [eɪ] [b] [l]

Appendix E

Grapheme-Phoneme Conversion Guide

The following consonant letters represent one sound:

d	[d] as in dog	P	[p] as in pig
f	[f] as in fish	R	[r] as in rain
j	[dʒ] s in job	V	[v] as in vision
m	[m] as in mom	Z	[z] as in zebra
n	[n] as in man	T	[t] as in ten

The following consonants can also be silent:

b	[b] as in boy Silent: lamb, bomb	L	[l] as in little Silent: would
h	[h] as in hand Silent: honest, hour	W	[w] as in water Silent: two
k	[k] as in kite Silent: knee		

The following consonants may represent more than one sound:

c	[k] as in candy [s] as in city [tʃ] as in cello	X	[g] [z] as in execute [k][s] as in fix [z] as in anxious
g	[g] as in get [dʒ] as in gem	Y	[j] as in yet [i] as in happy

The following combination of consonant letters may represent one sound:

ck	[k] as in pick	ph	[f] as in phoneme
le	[l] as in little	sh	[ʃ] as in ship
ng	[ŋ] as in long	wh	[w] as in what
tch	[tʃ] as in choice		

The following combinations of consonant letters may represent more than one sound

qu	[k] [w] as quick [k] as in quay	gh	[f] as in tough Silent as in through
ch	[tʃ] as in chore [k] as in chorus		

The following single vowel letters in single syllable words may represent the following sounds:

a	[eɪ] as in mate	[æ] as in mat
e	[iː] as in Pete	[e] as in pet
i	[aɪ] as in bite	[ɪ] as in bit
o	[oʊ] as in mope	[ɑː] as in mop
u	[j] [uː] as in cute	[ʌ] as in cut

The following vowel and consonant combinations can represent the following sounds:

au/ aw	[ɔː] as in cause, law	oi/ oy	[ɔɪ] as in boy, coin
ea	[iː] as in easy	oo	[uː] as in loot
ee	[iː] as in bleed	ui	[j] [uː] or [uː] as in suit, cruise
ei /ey	[eɪ] eight, ey	ou/ ow	[aʊ] as in house, cow
eu/ ew	[j] [uː] or [uː] as in neutral, few		
oa	[oʊ] as in boat		